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Bernhard Bierschenk

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Lund University
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Postal address

Cognitive Science Research
P.O. Box 7080
S-220 07 LUND
SWEDEN

Editor

Bernhard Bierschenk
Department of Psychology
Lund University

Adm. editor

Helge Helmersson
Department of Business Adm.
Lund University

Abstract

The presented study builds on the Agent-action-Objective (AaO) principle. It accommodates a unique theoretical framework for the development of a radically new methodological approach to the scientific study of intentionality and orientation. This approach will be called **Scanator**. It provides the means for rigorous measurement and representation of such mental phenomena as consciousness and consequently the subtle structures of mentality. Fundamental to the methodological development has been the idea of analysing discontinuity and qualitative stability in text building behaviour. Through the approach taken, it has been possible to discern the teleonomic component which is essential for the observation of phase transition and for evaluating its achievements. The presented study concentrates on the functional analysis of text building. In this respect, identification of textual agents and objectives as the originators of the co-ordinates of a language specific work space help in the establishment of the mental structure underlying natural language production. In the present context, mass-dependent and forceful interaction is restricted to the verbal flow processes involved in text production. Mass-independent and informational interaction on the other hand is reflected through the thermodynamic processes that produce the style of writing. The observable variables at the kinetic level show that Mono Zygotic Twins in their text production have been working in highly similar fashion. Though differences emerge when the perspective of the text producer is separated from his viewpoints. A consequence of this operation appears at the thermodynamic level where distinct differences in consciousness can be demonstrated between the twins.

The discussion in this article takes its departure in some common arguments from the "Cognitive Revolution". Scientists investigating cognitive processes defend the position that intelligent behaviour can be understood only within the context of programming. It is assumed that elaborated communication techniques are the key to the highest form of knowledge which is believed to be propositional. In contrast to the classical approach, the present assumes that the process of growing is inherent in the process of communication which requires the AaO model for direct information pickup. This model contradicts to the (p(X)) model underlying design and the study of detailed computer programs, in that it refers to the organism-environment interactions as studied by James J. Gibson's (1966, 1979). In agreement with the Gibsonian approach the AaO model advocates the primacy of flow descriptions. Up to now the absence of a scientifically acceptable method has made it impossible to achieve a clear cut separation of knowledge from *"con-scious-ness"*, which means *knowing together*. What **Mono Zygotic Twins** *know together* has always been prominent in any discussion of mental performance or intelligence. Moreover, its fundamental influence on behavioural outcomes is discussed in "behavioural genetics" (Royce and Mos, 1979). In one way or the other, both have been the subject of "generalisability" in the behavioural sciences (Lord & Novick, 1968; Cronbach, Gleser, Nanda, & Rajaratnam, 1972)

According to Grassé (1977, p. 65) the evolution of a conscious organism and its relation to physical reality is essentially based on **the eye**, **the hand** and their **co-ordination**. However co-ordination of the visual with the haptic perceptual system concerning hemispheric functioning in the brain has initially been studied by Sperry (1952, 1968). Changes in quantitative and qualitative properties as well as their impact on the eye-hand co-ordination seem to be of particular interest to a wide variety of scientists studying physical reality in relation to processes that lead to consciousness or mind. Harth (1982) conceives the eye as the "window on the mind". On the other hand, Sperry (1975, p. 429) in his reflections on his a priori inference (Sperry, 1952) concludes:

"... that consciousness is an operational derivative of activity in cerebral circuit systems designed expressly to produce their own specific conscious effects. The implication here of causal action upon as well as from neural events was yet to be appreciated".

Pushed by this kind of propositional statements, Povinelli's (1993) ambition in his article on the "reconstruction of the evolution of the mind" is to put forward arguments concerning the chimpanzee's ability of immediate attribution, which for Povinelli means to be "con-scious" of what is requested by a discrimination learning task. But Heyes (1993) questioned Povinelli's evidence, i.e. his ability of demonstrating experimentally the existence of consciousness in primates. As discussed by Blumberg and Wasserman (1995), it is obvious that Povinelli (1994) could not demonstrate any empirical indication of a chimpanzee's immediate information transfer to others.

Physical Causation

With the generalisation of the machine concept as expressed in the computer-mind analogy (Carello, Turvey, Kugler, & Shaw, 1984), brain-mind interaction has been defined as a system that is "information-tight". It is therefore not surprising that the familiar connectivity principle has returned as basis of central nervous integration. With this kind of approach in mind, it will be illustrated how Becker (1973) has attempted to reverse the reflex arc by modelling “re-afference” through simulating the

"encoding of experiential information". His ($Sensation_1 \rightarrow Action_1 \rightarrow Action_2 \Rightarrow Sensation_2$) model (Becker, 1973, p. 396) is based on the eye-hand co-ordination in pre-locomotor infants as investigated in the famous visual cliff experiments (Gibson & Walk, 1960). How humans come to experience their world and represent their knowledge has been the basic question to which Becker tries to give an answer by simulating the eye, the hand and their co-ordination within an artificial context

The eye. It is conceptualised as a "visual" perceptual system and operationalised as choice mechanism. The choices possible through the eye function are between viewpoints of black and white colour. In this sense the information processed is indicational. The activity of the eye directs the hand and the hand's efficacy is dependent on the regularities in the colouring. Turning black or white is represented as a non-panoramic, i. e. two-dimensional chequer-squared surface layout.

The hand. It is conceptualised as a grip and operationalised as a mechanism that can be either open or closed. This mechanism represents the "haptic" perceptual system which can move either horizontally or vertically. These states represent the injunctional information which is activity relevant. Indicational and/or injunctional information is non-specific and successfully delineated when a red square is positioned in the visual field of the eye.

The cliff. It is conceptualised as a smooth shelf with a textured foreground and a colourless background. The visual part is operationalised as patterned matrix. The dynamics induced on the brink of the cliff concerns the haptic sensory system represented by a "groping hand". This means that kernel sentences are proposed to cause the hand to move in order to increase its tactile sensitivity. It is assumed that intensity is highest where the surface becomes soft.

Modelling the ecological environment of the visual cliff through the simulation of sensory-motor co-ordination requires a successful processing of "positional change", which implies mechanical transformation. By means of the system's indication of transitional success, it is inferred that the system has "knowledge" of in what position the hand founds itself. Because the encoding requires a memory, it is conceptualised as the most central part of the system and exclusively founded on propositions. This means that it has "knowledge" to the extent that logical form can be imposed on experience. In principle, if logical mechanics can be used in the design of a machine that can compute any function that is computable then the organism's "self-indication" would be definable through the rules that direct discrete operations on discrete elements.

The underlying cybernetic hypothesis is that "self-indication" can be studied by means of the logic of inference and the "laws of form" (Spencer Brown, 1972). However, experience modelled on the basis of already known information is irrelevant to Gibson's framework of direct information pickup. Thus, a designed mind may have the capacity of computing "similarity" and establish "boundary conditions" but must work on the basis of a symbolic representation, which means indirect information processing. Manipulation of logical formulas and memories is taken as a pretext for the argument that one should have computable knowledge about the adequate environmental response. Moreover, when the viewpoints are of the same logical type and a perspective cannot be differentiated from feature detection, direction, and linear time, novelty is out of range, because the computational model is limited to the designed order of complexity. (For an extended discussion, see B. Bierschenk, 1984.)

Instantiating the simulation of designed sensory-motor co-ordination requires a projection mechanism that in the Newtonian sense can build up an elaborated architecture of S-R associations. Pointing and commanding form the base for such elementary processes as (1) conditional judgement (if-then anticipation), (2) classification

(generalisation) and (3) comparison (combination). In agreement with Young's (1978) reasoning, random possibilities are assumed to cause the occurrence of different responses leading to certain associative connections. On the basis of the neuro-motor assumption of a "reversed" reflex arc a locomotor function is proposed:

Periphery - efferent nerves - synapses - afferent nerves - CNS

What becomes "re-affirmed" (Holst & Mittelsteadt, 1950, p 464; Held & Hein, 1958) by the environment changes into S-R bonds, while non-affirmed randomly formed S-R associations become de-connected. It follows that experiential information directs the sensory system to respond to certain environmental features or to continue the organisation of particular patterns of bonded S-R associations. Holst and Mittelsteadt have coined it "The principle of reafference" which concerns the reciprocal action between the central nervous system and the periphery. In purely physiological terms, this principle can be concisely expressed ($E_1a_1a_2E_2$) which means that sense receptors are stimulated by signals (a_1) from an object or event with the effect of producing a nervous impulse (a_2) in return.

Becker's system operates with a "reversed reflex arc" and is thus comparable to the reafference principle. In the long run, it is expected that the re-affirmed connections become dependent on afferent return of impulses to the environment which means the establishment of a "cognitive code" (Cook, 1986). Its generation lifts the original neuro-motor assumption into the cognitive realm. As Grossberg (1982) conceives it, this kind of translation makes the mentioned elementary processes dependent on cognitive information processing. To be sure, the reafference principle can be used in simulating adaptation to an environment. However, Becker's conjecture of a strict environmental determinism suggests a hard moulded mind, which means permanent conformity to the controlling regime.

Note: It is Sperry's decisive achievement of having discouraged the general acceptance of a psycho-neural isomorphism in the form of the brain-mind identity hypothesis.

For scientists of the "Cognitive Revolution" (Sperry, 1993) it is evident that an understanding of the human mind requires a study of how humans *should* think, which is intimately related to the study of the universals of logic, language and symbolism in general. It is taken for granted that the architectural configuration of a brain, or cognitive code, or consciousness will advance our understanding of how cognitive functions work. Based on patterns of electronic circuits and linguistic elements as well as point-to-point sequential processing, the computer is conceived of as a "symbol handling machine" (Newell, 1981) which allows the building of expert systems. In this endeavour "intelligent structuring" and "flexible organisation" are the key concepts of the "knowledge industry" (Forester, 1981).

An immediate consequence follows in the argument that "cognition" is non-panoramic and expressible in the form of computer programs. Directed by the arguments from design, Becker's simulation of sensory-motor co-ordination is built on the "if-then" assumption of behavioural semantics which controls the syntactic associations of textual elements within a well-formed but changeable database. The design of syntactic patterns is used to control explicitly the imposition of form on randomly generated S-R associations. Implicit relations, on the other hand, are controlled by generalised propositions. The emphasis within Becker's system is on logical mechanics which means "logical invariance" and a need for semantic interpretation.

Intentional Causation

Characteristic of the reafference principle applied to the natural context of eye-hand co-ordinations is its locomotor rhythm which includes oscillation in the process of writing. Writing is therefore highly sensitive to variations in extero-specific information processing. Further, results from delayed feedback studies show that proprio-specific information processing is affected, if the feedback delay is less than 0.1 seconds. Apparently space-time co-ordinates guide the oscillation in textual movement. Gippenreiter & Romanov (1974, p. 245) investigated inner movement in the form of naturally occurring optomotoric movements, which are required for the proper functioning of the optokinetic nystagmus. The conclusion drawn from this observation and from Held and Freedman's (1963) experiments is that self-initiated movement accompanied by consistent visual re-afference is basic to normal development of sensori-motor co-ordination. Furthermore, evidence provided by Smith and Smith (1969) makes clear that the co-ordinates of real time and real space directly determine the rhythmic patterning in writing. Initial position and subsequent eye-hand displacements geometrically determine the verbal flow patterns.

Thus the emphasis within a biomechanical system is on "structural invariance" which has no need for logical mechanics and semantic interpretation. The functional, structural and dynamic aspects of the biomechanical system are basically represented by the eye, limb (hand, foot), and ground. These components constitute the experimental prerequisites for the simulation of the "visual cliff". The cliff represents the concept of depth from an ecological point of view. When both cliff and language functionally become co-ordinated at the ecological level, they constitute a multivariable system which is central for a demonstrative definition of multistability, and thus structural invariance.

A pillar in Gibson's ecological realism is the assumption that perception and action is founded on the organism's terrestrial environment, which is panoramic and has structure. Starting from higher-order components, which he calls affordances, the hypothesis is formulated, that the organism is *innately* endowed with a mechanism that makes possible an orientation through the perception of environmental "reflectancies", the way they emerge in a medium suitable for the particular organism. The difficulty with a direct utilisation of this definition in connection with language is that event structures are hard to ascertain at the same time as it is hard to imagine how these structures may effect text building behaviour.

If one can perceive the affordance of natural occurring discontinuities and distortions of the texture of objects and events, then the affordance of the edge at the top of a cliff may be conceived of as dangerous. It follows that dangerousness implies some kind of negative affordance that a biomechanical mechanism can pick up. However, whether or not an affordance is perceived, relies on the structure of the affordance. This structure becomes accessible through shifts in perspectivation. Thus, depending on one's point of observation and "terrestrial" movement, the function of the points of view is shifting.

At the ecological level, realism directs the development of a biomechanical mechanism for the pickup of extero-specific information. According to the Gibsonian law of information, specificational information is an important factor in the "haptic and visual" perception of objects and events (Gibson, 1966). Thus the developed mechanism for information pickup has to be species-specific and must have a certain character. This means at the ecological level that the mechanism must process topological information, resulting from a discrimination of variations in orientation.

Through studies of visual orientation produced by Regan, Beverly and Cynader (1979) it is demonstrated that highly specific pathways exist for processing of motion specific cues, and this uniqueness is absolutely necessary, because there is no uniqueness of signals. In addition, Kennedy's (1980) studies have made evident that this mechanism needs not necessarily work with information belonging to experience of vision only. This outcome supports a fundamental assumption of the Gibsonian approach, namely that proprio-specific information has an influence on the mechanism for information pickup. Hence, adequate motor action can be taken as evidence for a successful extraction or abstraction of an environmental affordance, which implies that topological information has been picked up.

Furthermore, studies of visual awareness were designed by Ball and Tronick (1971) to test the validity of the assumption that topological cues regarding modality and quality are processed. In a psycho-physical experiment, an infant of only a few weeks of age was confronted with symmetrically expanding shadows. The shadows specified the structure of an approaching object. This optical arrangement made it possible to show that the infant acted intentionally to an "impending optical collision". Even a three days old monkey, placed on the visual cliff, perceives the "depth" or "height" as indicated by its intention to avoid the cliff (Rosenblum & Cross, 1963). Thus, from the behaviour on the cliff, in the form of avoidance, intentional causation is inferred. Kaufman (1974, p. 456) comments on the cliff studies as follows:

"While we cannot conclude from this evidence that new-born infants are innately endowed with a capacity to perceive depth, the presence of this capacity at so early an age is still impressive."

But intentional causation does not give free-way to mentalistic explanations. On a strictly experimental basis, Held and Hein (1963) could show that a locomoting kitten exhibits behaviour that indicates the perception of "depth", but the perceptual mechanism of either dark-reared or passively moved kitten does not respond properly (1) to an impending optical collision with fast moving objects or (2) to simulated falling-off. The outcome of the experiment with a kitten suggests that the meaning of objects and events is generated under the conditions of (1) an organism that moves freely and (2) a medium that contains information about things that reflect light, vibrate or are volatile. It follows that the fitness of an organism implies active movement and intentional use of ecological information. With reference to these experiments it seems that Sperry's proposition, that humans and monkeys behave on the basis of a causal mediation of consciousness, is premature. It appears to be an example of the nomological fallacy, because his claim goes far beyond what his design allows him to test. It is mentalistic in the sense that naming becomes equal to explaining.

An Approach to the Naturalisation of Intentionality

According to the principle of reafference, motor adaptation to visual stimulation requires practice, This implies that sensory-motor co-ordination is something that is linked to the individuals intentionality. Since sensory-motor co-ordination has to be learned it can be considered as a transformation of earlier perceived events, and the result can be regarded as an abstraction. An attempt to naturalise intentional causation has been made by Kugler and Turvey (1987) in their experiments with "coupled wrist pendulum systems". In these studies learning to swing two pendulums at the same tempo but in opposite direction laid the ground for an understanding of how an abstraction may develop. However, according to their own

view, Kugler and Turvey (1987, p. 421) have not been able to give a demonstrative definition of abstraction, but offer the following refined formulation:

"... the singularities of kinematic flow fields are very close to the intuitive notion of a symbol: They are discrete and non-integrable and are potential information".

The basic idea behind the design of their experiments is that the development of a singularity is directly tied to "intentional causation". Its emergence is empirically founded, because it is dependent on continuous transformation. Moreover, it is implied that regularities in change can be sensibly measured only with reference to a particular individual. This requires a model that not only allows the differential processing of intentionality and orientation, but the differential processing of perspective and viewpoints as well. Demarcating perspective and viewpoints rests basically on the ability to make the **Agent** function an integrative component in the AaO model. It is namely the **Agent**-function that determines what viewpoints are chosen and how they change during text production.

In description, the verbal expression of the viewpoints of a text, called "textual viewpoints", is indicative of a particular orientation. Likewise, "textual agents" are indicative of one's intentionality, and therefore, contribute to the evolution of a particular perspective. If intentionality and orientation are allowed to play a central role in the study of textual movements, it is necessary to treat textual agents and textual viewpoints differentially. Thus intentional causation can be naturalised only through the development of a language specific work space. This is the only way in which intentional causation can get its demonstrative definition.

Furthermore, informational invariants become accessible only to the degree that self-reference can be detected. A precondition for the detection of self-reference is the study of ecological information processing through the parameters governing natural language processing. This kind of processing is possible if and only if (1) parameter flexibility is guaranteed, because text development, conceived of as viscous-elastic event, is dependent on versatility. Essential of this development is (2) parameter variability rather than exact reproduction. Through the direct processing techniques developed, ecological information can be picked up. The involved transformations are regarded as a developmental twist leading to (3) parameter operations that are independent of corresponding components in AaO model.

In the following, a rigorous test concerning the above mentioned parameter functioning will be presented. Any functional relation between textual agents as carriers of energy potentials and textual objectives carrying dissipated energy must have some explicit embodiment in the form of non-holonomic constraints. Testing the constraints with reference to Mono Zygotic Twins will show to what degree innate properties of the involved behaviour-genetic systems cause noticeable contrasts in the generation of strings of graphemes. Moreover it will be tested to what degree the folding transformations generate non-linear differences. With regard to the phenomenon of parameter and model dependency, it will in fact be tested if the following zero-hypothesis is true:

Hypothesis: The individual parameters and their relations to the AaO model are independent of some corresponding steps or components.

In essence, the dynamics of writing comes about through the AaO mechanism's stepping and rhythmic movement. It is expected that changes in movement, as reflected by the strings of graphemes, do not effect proportional changes in the function of the

AaO mechanism. On the whole, the test procedures concern the numerous discrete changes in the strings of graphemes and their possible differential effect on the development of distinctive state curves. From a strategic point of view these limit at the verbal flow level the contribution of active forces during oscillation. Its functional description builds on the off-setting of losses in dissipative structuring.

Experiment

Method

In order to separate experimentally the effects of perspectivating intention and orientation, it is sufficient to restrict the study to similarities and differences in the working of the AaO mechanism. The system of measuring these (dis)similarities has been modelled on the basis of the AaO axiom as described by B. Bierschenk (1991). The mechanical constraints determining the co-ordinates of a language specific work space have been studied by I. Bierschenk (1992). Constraints determining the texture of a text have been worked out. The texture of a text emerges as a result of the interplay between stability and change in the textual flow patterns. Similar to the observed individual-environment interaction on the cliff, textual interaction is backed up in the material through textual integration. As demonstrated throughout the present study, a system of computer programmes developed by H. Helmersson (1992) assists with routines for separating the text producer's perspective from his viewpoints and for extracting their structural relations. Moreover, O. Elstrup Rasmussen (1994 a, b, c) has contributed with a comprehensive theory of discontinuity of human existence. This theory is outlined on a very general level in order to model the implicate order of human existence. Among other things its generality has been the major source for fitting it to the methodological developments at Lund University in order to obtain an empirical foundation of the theory.

The coupling of the methodological development in Lund, Sweden with the theoretical development in Copenhagen, Denmark has during the academic year of 1994/1995 crystallised into the Copenhagen Competence Research Centre (CCRC), University of Copenhagen, Psychological Laboratory. In order to accommodate the Scandinavian origin of the developed theoretical framework for both theoretical and experimental work, the geographical association has been preserved in the name **"Scanator"**. It allows for the description of the flow-field couplings of language at three different levels.

At the first level of description, the flow fields of the language system have been taken into account. The second level of description has provides the necessary coupling of the flow fields. At the third level, of description perspective transformation is taken into account, resulting into distinct state curves specifying the emergent morphological profiles. The latter contain the control parameters that in turn specify the co-ordination of perception and the action of writing.

Activating the writing function means activating the AaO mechanism which transforms perception into rhythmic writing movements. Likewise, at the ecological level the mechanism works in a rhythmic manner and internal mechanical constraints become accessible. The Scanator relies on the assumption that intentional causation can neither be attributed to a "conscious designer" inside the head of the text producer nor to a "genetic plan" that provides the program for text development. Last but not least, intentional causation cannot be anticipated to disappear into S-R connections either. Furthermore, it is a demonstrated empirical fact, that intentionality becomes visible first as a result of the rhythmic movements of the components of the AaO mechanism. Intentionality is not immediately accessible, because language is characterised by an open surface. A measure on the openness of a surface is the

amount of stitching to be carried out by the repair routines. Correspondingly, differences can be observed in the supplementation of substance. This means that textual material is placed into the open fields.

Furthermore, the constitutional components of the AaO mechanism not only repeat themselves in the algorithmic processing and repairing, but give determination to text conceived of as a soft moulded viscal-elastic network that behaves like a **floating sweep net**. This makes natural language as carrier of consciousness (I. Bierschenk, 1989) comprehensible at the thermodynamic level of description. It follows that the network is conservational. What is conserved is specified by the singularities that control the network development as an organising process by which the text is constructed dynamically through its many interacting parts.

Subjects. Poor writers of essays but strong in command of analytical skills is the traditional opinion about young adults with a technical orientation and who are between 15 and 20 years of age. The technological context of the individual student is believed to influence his writing negatively. The goal population addressed, therefore consists of students who meet the problem of making a decision concerning their educational career. Solving this choice problem implies a proliferation of orientation. Founded on the technological orientation, an accessible population is easily defined and differentiated. A selection of 90 students of 16 to 17 years of age and enrolled in the programs of technical education form a natural and suitable sub-population. Those 19 students who had made French their choice of foreign language study were unknowingly exposed to the experimental material. Part of the selected group is a pair of Mono Zygotic Twins, which from a behaviour-genetic point of view make up two identical systems (A1 and A2). Both systems are the tokens of a biological system of a particular locomotor style, namely writing. Hence, the token systems provide an exceptionally well suited frame of reference for carrying out a controlled study of their biomechanical constraints.

Materials. From an ecological point of view the environment is conceived of as all the effects of the milieu influencing the working of the AaO mechanism. A radical reorientation in the experimental definition of stability and changes in the environment is present in a series of four pictures published by E. J. Gibson and R. D. Walk (1960). The pictures are showing the placement of a child on an experimentally modified texture of a surface layout. Its task is to simulate a cliff and the result is a characterisation of the qualitative properties of optical pattern dynamics. These are specified by the singularities which organise the optical flow fields. Evolving qualitative properties are examined on the basis of the movement through the simulated environment. From either side of the cliff, the child's mother tries to lure the child into action. In front of the deep side, the child is pictured in a risky situation which implies danger for life. The material handed out to the subjects represents the child's sensory-motor work-space in A-4 format. Its description depends on the way in which this work-space is explored and the information picked up is transformed into written form.

Design and procedure. The purpose of text building is a sequential organisation of graphemes into strings and a sequencing of strings into patterns of strings. From a behavioural point of view, successful writing may be very different at different occasions and in various languages. In order to be able to test this assumption, the picture series was handed out four times and has at all occasions been described in Swedish as well as in French. The first occasion appeared at the end of the Spring term, June 2, 1993. The second was judged to be appropriate at the beginning of the autumn, September 10, 1993. The third occasion appeared in the following Spring, March 3, 1994. A final presentation was possible at the end of this term, June 3, 1994. At these occasions A1 and A2 were together attending their French class. The

class were assigned the task of writing down a description of the sequenced pictures of the visual cliff-experiments both in their native language, Swedish, and their foreign language of choice, French. Moreover, the sequence of events pictured, had to be described in the form of a narrative. They were told that the pictures concern an experiment. No information was given about the purpose with the experiment. At the first occasion it was just natural to begin text production with the French assignment. The same procedure was followed at the second occasion. At the third occasion the procedure was reversed and at the fourth occasion the order of production was free of choice.

The assumption that A1 and A2 will perform in highly similar fashion is based on the relation between biological variations responsible for differences in the phenotypic expression of analytical ability as measured by tests of intelligence (IQ). The IQ for Mono Zygotic Twins reared together accounts for 75-80% of factor variation (Erlenmeyer-Kimling & Jarvik, 1963, p. 1478). Moreover, the Grade Point Average (GPA) of A1 and A2 in Swedish essay writing is five points at a five-point scale, respectively. The respective GPA's in French were four points at the five-point scale by the time of the first test occasion. Against this background the following hypothesis was set-up:

Hypothesis: Independent of language and occasion, the Mono Zygotic Twins will not differ in their performance.

To test this hypothesis according to the following treatment model

(**System** (A1, A2) x **Occasion** (1-4) x **Language** (1 = Swedish, 2 = French))

is the purpose of the Generalised Linear Model (GLM) of MINITAB (1994). In applying the MANOVA (Winer, 1971) to the observables (App. 2), it is expected that a simple multivariate generalisation of the univariate analysis of variance yields the study of A1 and A2 concerning their location in a multidimensional measurement space spanned by the depend variable which is a vector.

The task of the model is to establish the degree of similarity in performance. In this connection, Wilks' test statistics is one of several well-known statistics (e.g. Lawley-Hotelling, Pillai's, or Roy's) that has been selected with the purpose to perform a parameter estimation. In the test of the "realness" of the differences among the centroids, Wilks' test indicates the discriminative power of the measurements concerning the treatment effects. If and only if a zero-hypothesis of no differences in the location of the centroids is rejected, an inspection of the univariate F-ratios becomes an option for the separate variates. However, these tests are not independent and should be interpreted only if a MANOVA zero-hypothesis has been rejected (Bock, 1975; Cooley & Lohnes, 1971; Tatsuoka, 1971).

Results

The First Level of Description: Flows Fields

The **spatial parameter** governs the layout of the texture of the verbal flow fields. In its simplest form the layout consists of the total amount of graphemes and spaces produced during the course of writing. Both complexity of the patterns of graphemes and the pattern of a given grapheme determine the periodicity in the flow. In writing, a cycle is completed when a number of graphemes has been put together and arranged in non-random occurring sequences. A full cycle is finished when all

spatial and temporal conditions have been satisfied. It is a fundamental prerequisite for the investigation of variations and co-ordination that the critical time factors governing sensory input and motor output can operate freely during writing.

The **temporal parameter** requires the definition of a period and a specification of the values it can take. These values are the graphemes (. ? !). In its simplest form the length of a period is no more then graphemes and spaces in-between them. In order to allow for an analysis of its sequencing, a second time parameter is needed. It concerns the asymmetrical spacing within periods by means of fractions. The second parameter takes as its values the graphemes (, ; :) and strings of graphemes like ('and', 'or', 'which', 'who', 'that', etc.). Immediately stated, the origin of a period has to be identified if co-ordination of multi-joint movements shall become observable in both the spatial and temporal domain. Therefore, textual transformation requires a suitable frame of reference in which variability and rhythmic movement can be observed. Based on time parameters, the sequencing of graphemes can be defined over varying intervals. What differences that A1 and A2 have produced in their cyclic patterning of graphemes is shown in Appendix 2.

In the focus stands viscosity and elasticity in the sensory-motor control of writing and its relation to the phase locking of the evolving cycles. Characteristic of the process of writing is that the sequencing of graphemes repeats itself irregularly but in rhythmic return through a cycle of changes. The initial position and subsequent eye and hand displacements determine what Gibson calls "flow patterns". It follows that the critical regions in the organisation of the "verbal flow patterns" provide the major source of information on the development of some attractor states.

A1 and A2 have been equally energetic in transforming their intentions into an oscillating out-flowing energy distribution. Moreover, the distribution is marked by insignificant variations over occasion and language. What makes the comparison between occasions and languages interesting is that the sensori-motor co-ordination between the eye (AaO on the macro level) and hand (AaO on the micro level) has produced the same causal processes of forces and flows in the physical expansion of the texture.

Expansion over time and periodicity is only trivially different as manifested by the reported observations. The sensitive procedures of the GLM confirm the zero hypothesis of absent main effects as shown in Appendix 2. Obviously, A1 and A2 have been equally effective in spacing and timing. It has been expected that the plasticity in writing would be highly similar with respect to individual variations in timing. Because of the very restricted frame of reference it was further anticipated that writing would vary just trivially over the seasonal time-scale.

However, in the co-ordination and transformation of the surface layout of a text, structures constitutional of a text, do not develop exponentially with expanding text mass (I. Bierschenk, 1992). Structural development is dependent on various joints and actions that form the movements of the AaO mechanism in a rhythmically and functionally balanced fashion. Therefore, the a-component addresses a relation that specifies a certain "mode of resource use" (Ghiselin 1981; Kugler & Turvey, 1987).

The Second Level of Description: The Coupling of Flow Fields

The **a-parameter** governs the dynamics of "textual movement patterns" which rests on the bend, shift and translation including the transformation indicated by the a-function. This function makes possible the development of the dissipative structures characteristic of verbal flow processes. The function performed by the a-component can therefore be likened with the component of a dynamic and soft-moulded pendulum. In text production it is represented (simulated) by the verb. Because the a-component

is now treated as the marker of an affinity relationship (B. Bierschenk, 1993), the observed distributions of the A-O-couplings are counted as "blocks". As shown in Appendix 2, only insignificant differences are characteristic of distribution of this parameter.

As soon as a verb has been identified there exists also an A- and O-variable. Both are functionally dependent on the borders defined by the joints. That is to say, the "functional clause" provides the linkage to the language specific work space. Dependent on the textual elasticity and viscosity, the macroscopic A- and O-components leave distortions on the texture (the surface) as the text producer moves on. These distortions are marked by dummies and conceived of as indicators of elasticity.

The **Dummies** of the A- and O-parameters concern the functional couplings between the A's and O's. The numerical analysis shows that the variations and movements in text production have generated similar block distributions. Their testing has provided evidence for similitude between A1 and A2 concerning the establishment of a dynamic regime. As a result of the negligible differences, the rhythmic movement of the pendulum has generated only insignificant variations between A1 and A2. In the course of writing they obviously make use of the linkage mechanism in much the same way and independent of the type of language and occasion involved. The corresponding test statistics is reported in Appendix 2.

The macroscopic state variables and the microscopic formation of chained relations between various clauses include self-reference between dummies. At the microscopic level restorative and dissipative forces can be identified that functionally yield reparation, manifesting itself in the rigidity of the textual surface. Rigidity is the effect of the linear functioning or stiffness in writing-reading-rewriting cycles.

By a certain set of rules the distortions of the texture are repaired with textural material. This means that the dissipation implicit in stiffness cannot be momentarily interpreted regardless of at what point in time they were detected (I. Bierschenk, 1992). Strings used in repairing the frictions need not be considered explicitly in the characterisation of the pendulum's operations. The statistical tests confirm that the resolution of the frictions need not be considered definitely in the process of co-ordinating two functional entities into a unity or block. In this sense the asymmetrical relations of the inner dynamics are preserved. The test of the variations in Appendix 2 of the identified distortions indicates that the variations are negligible.

The main concern of studying the linkage mechanism is to get an understanding of text building viewed as a viscal-elastic event. The viscal component of the verbal flow is associated with its inertia, while the elastic component is associated with the force of the flow. Appendix 2 gives the natural logarithm (ln)-values resulting from a scaling of the nesting relations produced during textual transformations. The scaling of dependency relates the timing in text building behaviour to text mass and the length of text as defined over the blocks.

Movement patterns are typically multiplicative in nature which suggests a logarithmic transformation of the verbal data prior to a statistical analysis. The statistical test of the logarithmically scaled relationship between viscosity and elasticity indicates for A1 and A2 only insignificant differences in the mode of resource use. Picking up information and transforming it into verbal expressions shows negligible variations over the occasions and similarly, variations in viscosity and elasticity are only insignificantly different over languages.

According to the conventional levels of significance, A1 and A2 provide the physical context in the cyclic processing and development of a language specific work space that is obviously dependent on the same kind of kinetic dynamics. The combined

measures imply that the overall conservation of information carried by the verbal flows gives rise to the same kind of configurational stability in their dynamic pattern complexes. It follows that A1 and A2 have been equally successful in their writing performance. But the way in which the kinetic properties lawfully compile these patterns into stable **state variables** depends on the strict A-O dependency in the linkage mechanism. By stipulating the co-operation between both it creates the particular constraints governing perspective transformation.

The Third Level of Description: Perspective Transformation

In the process of step-cycle moves, the perspective is continually changing which means that viewpoints are differentially perspectivated. Any possible point of observation may become a viewpoint and vice versa. In the course of text construction, points of view may change functionally into points of observation. The viewpoints of a text are usually scattered in such a way that some state variables can be identified and extracted. The interaction with an environment generates behavioural information which contributes to the pattern dynamics and attracts the individual toward certain environmental points of view. These can be perceived only to the degree that the individual can incline his angles and shift his perspective until their ecological significance has been picked up. But an informational structure can be determined first when all points are displayed in agreement with their geometrical relations and represented graphically. In continuous forward moves, point attractors develop and become characteristic of the dissipative fields. These are the fields of tension where the verbal flows of the text producer meet the information flows of the environment. These fields are relatively short-lived, because they are dependent on momentary point-distribution.

Similar to perceptual constraints, state variables function as constraints in the selection and development of a number of possible paths. Thus the information on text building behaviour is defined in the same work space as the state variables of that space. It follows that one trajectory is selected from among many virtual trajectories. Characteristic of the trajectories of view- and standpoints is that the points are differently distributed, but a mutual curvature of neighbouring points exists which implies an independent motion. Too widely diffused standpoints indicate the absence of a demonstrable path.

The observation of the absence of a Figure component in (A2 F1) is an extra ordinary case implying that the viewpoints are too widely diffused. This is probably an effect of an extreme concentration of attention on the surface layout of the cliff. The absence of any state variables in the Ground is not an unusual case but occurs from time to time. Examining and describing the visual cliff at different occasions would show to what degree A1 and A2 differ in their perceptual strength of extracting or abstracting the negative affordance of the cliff.

The process of extracting the point attractors from text requires that all patterns of strings of graphemes are tested for their distinctiveness. A striking fact in their agglomeration is that diverse and hybrid strings can be assembled at various occasions into clusters which means that ordered phase-locked patterns correspond to attractor states or singularities. The developing affinity relations are consequently not strictly a priori but functional. Several affinity matrices are the key for discovering the minimally sufficient number of terminal states. Appendix 2 indicates the distribution of identified terminal states. The computation of state variables is based on the calculation of a "minimal loss of information" (Ward, 1963), which is expressed as a minimal increase in the Error Sum of Squares (ESS). An ESS-value (ESS > 1) indicates a phase transition which is responsible for the grouping of the identified textual patterns. Appendix 2 shows only unimportant component effects. Thus, agglomerating textual

pattern dynamics into naturally occurring groupings is synonymous with discovering phase transitions. They represent singular boundaries that separate the patterns of movement in text production. An additional restriction concerns the constraints governing the configurational ordering of the grouping in the language specific work space. The restriction on the partitioning in the agglomeration of identified patterns generates the **terminal states** of the work space. These produce the equilibrium points in text production where reality meats virtuality.

Point attractors constitute the terminal states of a system whose strength is a function of the transformational strength of its **state attractors**. The state attractors are from a formal logical point of view the topologically defined **invariants** manifested in the points where bifurcations arise. New state attractors can interact with other local state attractors and thereby form an intricate configuration of singularities. Abrupt or unexpected changes in the ESS-values imply a hysteresis and the emergence of a new path. Through a topological approach that approximates the relationship among various parts of a text as **a unity** in a plan, the complexity in the dependency relations can be made visible as shown in Appendix 3 and 4.

Twin A1

Progression in text building behaviour implies a development in which every new periodical phase is characterised by distinctive aspects, which increase the efficiency of the eye-hand co-ordination in transaction with the environment. A concise description of the qualitative changes in A1 connected with the conservation of consciousness is given in Table 1.

Table 1.

Global Boundary Conditions in the Perspectivation of A1

Test	Swedish Figure	Ground	French Figure	Ground
2/6-93	Probing	Approach Path	Probing	None
10/9-93	Protection	Prospection	Obscurity	None
4/3-94	Danger for Life	Blurredness	Exposure to Danger	None
3/6-94	Delimitation of Path	Luring	Delimitation of Path	Sensitivity to Height

Despite highly similar developments at the first and second level of description, distinctly different developments can be observed in the profiles at the third level as shown in Appendix 3.

Independent of language, Table 1 makes obvious that the experimental nature of the visual cliff is in the focus of attention. *"Probing"* or testing a child's sensory-motor co-ordination on the basis of the established gradient is taken as an indicator of an adequate *"Approach Path"* in a situation where the impression of supporting surface texture suddenly changes into a sharp drop. A teleonomic component seems to couple the individual profiles over time as indicated by their global state attractors. A consequent continuation in progression manifests itself as *"Protection"* which is the point where the developed path determinate the second occasion. The complementary analysis of the French text makes obvious that it concerns the *"Obscurity"* of the surface layout" which requires *"Prospection"* as reasonable conduct. Thus the control factor in the Ground implies an anticipation of dangerous movements by the child.

By means of a totally transparent table top, "depth" is simulated through substance and absence of substance. In order to evoke variations in behaviour, this environmental constraint is set off in that the child's mother is introduced with the purpose of inducing locomotion. As an unexpected consequence, this measure turns the environment into a *"Blurredness"* and the behavioural outcome is not only "Exposure to Danger but *"Danger for Life"* as well. It remains a particular uncertainty. To what degree the child selectively will pick up the negative affordance of the gradient lying in the texture gets its expression in *"Delimitation of Path"*. Depending on the way the child locomotes over the two sides of the surface *"Sensitivity to Height"* is inferred as determinant of the behavioural outcome. Moreover, the effectivity of the determinant is highly dependent on the way the experiment was designed. It follows that the infant's movement is only partly dependent on sensory-motor co-ordination at the brink of the cliff, because its physical attraction competes with the emotional attraction of the child's mother.

Conclusion. In agreement with Gibson's ecological realism, A1 has observed central flow field properties and transformed the resulting individual-environment interaction into verbal flow fields resulting in the emergence of a **teleonomic** component that reflects a noticeable degree of consciousness in regard to the "confoundedness" of the experiment.

Twin A2

The global state attractors reproduced in Table 2 affirms a major deviation in orientation. In the French case, a global attractor is absent in the Figure component but present in the Ground. The reverse order is materialised in the Swedish case.

Table 2.

Global Boundary Conditions in the Perspectivation of A2

Language	Swedish		French	
Occasion	Figure	Ground	Figure	Ground
2/6-93	Enterprising Spirit	None	None	Ambiguity
10/9-93	Focusing	Obstacle	Stability	Inevitablity
4/3-94	Sensitivity to Height	Overriding	Foolhardiness	None
3/6-94	Negative Affordance	None	Luring	Negative Affordance

It is therefore only natural to consider them in a reciprocal manner. The variety of information sources in the pictured sequence of events is captured in the outcome of the French writing. In a very real sense, the Ground of the cliff-mother-context interaction models an *"Ambiguity"* with respect to possible courses of action in the given test situation. The controlling factor in the Figure of the Swedish text behaves correspondingly in that *"Enterprising Spirit"* emerges as the appropriate terminus. Its task is to constrain the situation in such a way that only one course of action overwhelms other possible courses. The progression toward the next period makes clear that *"Focusing"* means selective attention and a concentration of energy in relation to the *"Obstacle"* emerging in the Ground.

Through a shift of perspective in the French text it becomes obvious that the child's *"Stability"* means a tenacious behavioural action toward some goal. His dominating actions are relatively independent of the ecological conditions related to the texture of the surface layout. The *"Inevitability"* or one-time event of the resulting course of action constitutes the controlling factor in the Ground. The third step in the

progression, implies adventurous action which means that *"Sensitivity to Height"* fails to emerge as a natural clue to danger.

The Ground of the Swedish writing acts complementary and makes this point of view completely clear. *"Overriding"* means that the gradient of the surface layout lacks meaning. Moreover, *"Foolhardiness"*, which is the outcome of the corresponding French version, backs up the evidence that the infant is conceived of as mother's spirited acting child. During the final progression a phase is reached where the most critical factors emerge. *"Luring"* stands out as the controlling factor of behavioural development. This means in regard to A2 that the method of inducing locomotor crossing of the deep side has out-performed the ecological significance of the Cliff and thus its *"Negative Affordance"*. This result is a demonstration of the teleonomic component in a situation where non-consciousness has been manifested.

Conclusion. With reference to the pictured series of events as functional link between awareness and consciousness it must be concluded that A2 is non-conscious. By this is meant that the importance of the particular affordance has not been extracted at the moment of perception.

Discussion

The effort in the present study has been directed toward a demonstrative definition of the degree of consciousness in genetically identical systems. Making consciousness explicit in the given situation means making the environment known under the condition that the medium for reflecting structural qualities is natural language. It has been presumed that the movements in language make the shifting of viewpoints operational and help unfolding the structure of the underlying perspective. Moreover, the specific mode of writing, selects particular viewpoints according to a certain orientation. In the process of writing, these are not only intentionally used but selectively expressed, which implies that their teleonomic achievement is evaluated (Monod, 1972).

At the second level of analysis, a statistical evaluation of the agglomeration of the patterns of textual elements into point attractors shows only negligible differences with reference to A1 and A2 as well as over languages and occasions. The co-operative assembling of dynamic patterns into a configuration through the pendular clocking mode is brought about by a transformation of aggregates of nested and joint textual element complexes into a single functional unit. But its existence can only be demonstrated through its functioning in the generation of a typical state curve. Its task is to characterise the mental processes that govern language production and to foster an understanding of the actual process of becoming conscious.

As illustrated in the Appendices 3 and 4, this trajectory are independent of the mechanical processes at the first and second level. Each trajectory rebounds in its own particular way the specific properties of a particular perspective. On the basis of the results it can be concluded that the specific writing styles of A1 and A2 have contributed to the development of certain dissipative structures.

With respect to their qualitative solution, it can be stated that the differences in perspectivation are obvious and distinct. An unexpected result of the seasonal progression is a need for diversification and consequently a transcendental resolution of consciousness. A striking outcome of this need is that it has been possible to evaluate the achievement of the teleonomic component, in that non-linear differences in the degree of consciousness of A1 and A2 have been demonstrated. The necessity of the existence of a teleonomic component lays just in the need for transcendence. It is aimed at transforming the perspective as well as made experiences into growing consciousness. The growth becomes visible through qualitatively distinct courses of action. It follows that

each global attractor is associated with a certain state change in the formation of the mental structure specifying the particular twin. The resulting morphological profiles have made explicit that language production involved in the experimental task, has the potential of letting one "see" the differences in consciousness of Mono Zygotic Twins.

References

Ball, W., & Tronick, E. (1971). Infant responses to impending collision. Optical and real. *Science, 171*, 818-820.

Becker, J. D. (1973). A model for the encoding of experiential information. In R. C. Schank & K. M. Colby (Eds.), *Computer models of thought and language* (pp. 396-434). San Francisco: Freeman.

Bierschenk, B. (1984). *The split between meaning and being* (Kognitionsvetenskaplig forskning, No. 3). Lund, Sweden: Lund University, Department of Psychology.

Bierschenk, B. (1991). *The schema axiom as foundation of a theory for measurement and representation of consciousness* (Kognitionsvetenskaplig forskning, No. 38). Lund, Sweden: Lund University. (ERIC Document Reproduction Service, No. ED 338 650, TM 017 363)

Bierschenk, B. (1993). *An experimental approach to the functional analysis of text building behaviour. Part I. The verbal flow* (Kognitionsvetenskaplig forskning, No. 47). Lund, Sweden: Lund University, Department of Psychology.

Bierschenk, I. (1989). *Language as carrier of consciousness* (Kognitionsvetenskaplig forskning, No. 30). Lund, Sweden: Lund University, Department of Psychology.

Bierschenk, I. (1992). *The pendular movement of text building* (Kognitionsvetenskaplig forskning, No. 42). Lund, Sweden: Lund University, Department of Psychology.

Blumberg, M. S., & Wasserman, E. A. (1995). Animal mind and the argument from design. *American Psychologist, 50*, 133-144.

Bock, R. D. (1975). *Multivariate statistical methods in behavioural research.* New York: McGraw-Hill.

Carello, C., Turvey, M.T., Kugler, P.N., & Shaw, R. E. (1984). Inadequacies of the computer metaphor. In M. S. Gazzaniga (Ed.), *Handbook of cognitive neuroscience* (pp. 229-248). New York: Plenum Press.

Cook, N. D. (1986). *The brain code. Mechanisms of information transfer and the role of the corpus callosum.* London: Methuen.

Cooley, W. W., & Lohnes, P. R. (1971). *Multivariate data analysis.* New York: John Wiley.

Cronbach, L.J., Gleser, G. C., Nanda, A. N., & Rajaratnam, N. (1972). *The dependability of behavioural measurements. Theory of generalisability for scores and profiles.* New York: Jon Wiley.

Elstrup Rasmussen, O. (1994 a). *The discontinuity of human existence. Part I. The fundamental concepts of human existence and the relation between the singular and the super singular* (Kognitionsvetenskaplig forskning, No. 50). Lund, Sweden: Lund University, Department of Psychology.

Elstrup Rasmussen, O. (1994 b). *The discontinuity of human existence. Part II. The general and the specific theories of discontinuity* (Kognitionsvetenskaplig forskning, No. 51). Lund, Sweden: Lund University, Department of Psychology.

Elstrup Rasmussen, O. (1994 c). *The discontinuity of human existence. Part III. Perspective text analysis. A methodological approach to the study of competence* (Kognitionsvetenskaplig forskning, No. 52). Lund, Sweden: Lund University, Department of Psychology.

Erlenmeyer-Kimling, L., & Jarvik, L. (1963). Genetics and intelligence. A review. *Science*, *142*, 1477-1479.

Forester, T. (1981). *The micorelectronics revolution. The complete guide to the new technology and its impact on society*. Cambridge, MA: The MIT Press.

Ghiselin, C. R. (1981). Categories, life and thinking. *The Behavioural and Brain Sciences*, *4*, 226-313.

Gibson, E. J., & Walk, R. D. (1960). The visual cliff. *Scientific American*, *202*, 64-71.

Gibson, J. J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin.

Gippenreiter, J. B., & Romanov, Y. (1974). A method of investigation of the internal form of visual activity. In R. B. McLeod & H. L. Pick (Eds.), *Perception. Essays in honor of James J. Gibson* (pp. 227-249). Ithaca; NY: Cornell University Press.

Grassé, P. P. (1977). *Evolution of living organism. Evidence for a new theory of transformation*. New York: Academic Press.

Grossberg, S. (1982). *Studies of mind and brain*. Boston: Reidel.

Harth, E. (1982). *Windows on the mind. Reflections on the physical basis of consciousness*. Brighton, Sussex: Harvester Press.

Held, R., & Freedman, S. J. (1963). Plasticity in human sensori-motor control. *Science*, *142*, 455-461.

Held, R., & Hein, A. (1958). Adaptation of disarranged hand-eye co-ordination contingent upon re-afferent stimulation. *Perceptual and Motor Skills*, *8*, 87-90.

Held, R., & Hein, A. (1963). Movement-produced stimulation in the development of visually guided behaviour. *Journal of Physiological Psychology*, *56*, 872-876.

Helmersson, H. (1992). *Main princples for perspective text analysis via the PC-system Pertex* (Kognitionsvetenskaplig forskning, No. 41). Lund, Sweden: Lund University. (ERIC Document Reproduction Service, No. ED 352 405, TM 019 324)

Heyes, C. M. (1993). Anecdotes, training, trapping and triangulating. Do animals attribute mental states? *Animal Behaviour*, *46*, 177-188.

Holst, von, E., & Mittelstaedt, H. (1950). Das Reafferenzprinzip (The principle of reafference). *Die Naturwissenschaften*, *37*, 464-476.

Kaufman, L. (1974). *Sight and mind. An introduction to visual perception*. New York: Oxford University Press.

Kennedy, J. M. (1980). Pictures and the blind. *Journal of the University Film Association*, *32*, 11-21.

Kugler, P. N., & Turvey, M. T. (1987). *Information, natural law, and the self-assembly of rhythmic movement*. Hillsdale, NJ: Lawrence Erlbaum.

Lord , F. M., & Novick, M. R. (1968). *Statistical theories of mental test scores*. Reading, MA: Addison-Wesley.

Minitab Ltd. (1994). Minitab reference manual. Release 10 for Windows. Birmingham, England: Coventry, 3 Mercia Business Village, Westwood Business Park.

Monod, J. (1972). *Slump och nödvändighet (Chance and necessity)*. Stockholm: Bonniers. (Original work published 1970)

Povinelli, D. J. (1993). Reconstructing the evolution of mind. *American Psychologist, 48*, 493-509.

Povinelli, D. J. (1994). Comparative studies of animal mental state attribution. A reply to Heyes. *Animal Behaviour, 48*, 239-241.

Regan, D., Beverly, K., & Cynader, M. (1979). The visual perception of motion in depth. *Scientific American, 241*, 136-151.

Rosenblum, L. A., & Cross, H. A. (1963). Performance of neonatal monkeys in the visual cliff situation. *American Journal of Psychology, 76*, 318-320.

Royce, J. R., & Mos, L. P. (Eds.). (1979). *Theoretical advances in behaviour genetics*. Alphen aan den Rijn, The Netherlands: Sijthoff & Noordhoff.

Smith, K. U., & Smith, T. J. (1969). Systems theory of therapeutic and rehabilitative learning with television. In R. H. Geertsma & J. B. Mackie (Eds.), *Studies in self-cognition. Techniques of videotape, self-observation in the behavioural sciences* (pp. 386-429). Baltimore: The Williams & Wilkins.

Spencer Brown, G. (1972). *Laws of form*. New York: Julian Press.

Sperry, R. W. (1952). Neurology and the mind-brain problem. *American Scientist, 40*, 291-312.

Sperry, R. W. (1968). Hemisphere deconnection and unity in conscious awareness. *American Psychologist, 23*, 723-733.

Sperry, R. W. (1975). In search of psyche. In F. G. Worden, J. P. Swazey, & G. Adelman (Eds.), *The neuro-sciences. Paths of discovery* (pp. 425-433). Cambridge, MA: The MIT Press.

Sperry, R. W. (1993). The impact and promise of the cognitive revolution. *American Psychologist, 48*, 878-885.

Tatsuoka, M. M. (1971). *Multivariate analysis. Techniques for educational and psychological research*. New York: John Wiley.

Turvey, M. T. (1990). Co-ordination. *American Psychologist, 45*, 938-953.

Ward, J. H. (1963). Hierarchical grouping to optimise an objective function. *Journal of the American Statistical Association, 58*, 236-244.

Winer, B. J. (1971). *Statistical principles in experimental design* (2nd ed.). New York: McGraw-Hill.

Winfree, A. T. (1990). *The geometry of biological time*. Heidelberg: Springer-Verlag. (Original work published 1980)

Young, J. Z. (1978). *Programs of the brain*. Oxford: Oxford University Press.

Appendix 1: Text Production

French

System A1, Occasion 2/6-1993

Sur les photos c'est un bébé et sa maman. Le bébé est sur un table. Dans les photos différentes nous voyons le bébé sentir et découvrir verre. La maman voit son bébé avec une sourire. Elle il encourager. Le bébé est très curieux. Il veux voir et sentir tout. Il fait tout avec une sourire sur les lèvres.

System A1, Occasion 10/9-1993

Dans le picture c'est quatre petite pictures. Dans les pictures c'est un enfant et une femme. L'enfant est sur une table à carreaux. Nous voyons l'enfant dans les angles différentes. Sur picture 1, l'enfant est en face. La femme est derrière. L'enfant riant. Il vais au ses mains et ses genoux. Sur picture 2, l'enfant va hors de camera. La femme il regarde. Dans picture 3, l'enfant sente un plaque de verre. Dans picture 4, a femme appelle l'enfant qu'elle regarde.

System A1, Occasion 4/3-1994

Dans le papier on voit une série des pictures avec un enfant et une femme. Nous voyons l'enfant sur une table. La table est divisée en deux parts - un part a carreaux, et un part transparent, comme une fenêtre. Nous voyons l'enfant aux angles différents, quand il va à se mains et se genoux pour examiner les matériels différents, pendant quoi la femme l'encourage.

System A1, Occasion 3/6-1994

Sur le papier on voit une série de pictures d'un enfant. Il est sur un table à carreaux. La série est divisée dans quatre pictures où nous l'enfant voyons sur des angles différents. Quand il va à ses mains et ses genoux, il investige la table. La table est divisée de deux parts - un à carreaux et un transparent, comme une fenêtre. Tout le temps une femme regarde et encourage l'enfant.

French

System A2, Occasion 2/6-1993

Voici un enfant. Il est dans un projet pour regarder comment des enfants réagissent sur les carreaux noires et blancs. L'enfant s'appelle Jean-Pierre. La dame avec Jean-Pierre est sa maman. Elle lui regard. Il n'est pas facile de promener sur la table, mais Jean-Pierre rire heureusement à sa maman. Quelle aventure!

System A2, Occasion 10/9-1993

C'est un enfant avec sa mère. Il s'appelle Jean-Pierre. Jean-Pierre est sur la table à carreaux. Au bord il y a un fenêtre que reflète les carreaux. On va voir si Jean-Pierre veut se promener de sa mère sur la fenêtre. La fenêtre ressemble à un trou.

System A2, Occasion 4/3-1994

L'enfant sur la table est part d'une expérimentation. On va peut-être voir si l'enfant va continuer de la table à carreaux, de la fenêtre qui avec un miroir font l'illusion d'être un trou, jusqu' à maman.

System A2, Occasion 3/6-1994

Je crois que c'est un enfant qui est part d'une expérimation. On va voir si l'enfant veut ramper de la femme, peut-être sa maman, à l'autre côté. La picture c'est là. Il y a une table à carreaux, et sur une part de la table il y a une vitre et un miroir qui ensemble ressemblent à une trou. L'enfant va ramper de la femme? On va voir.

Swedish

System A1, Occasion 2/6-1993

På papperet ser vi en bildserie på en baby och hans mamma. Babyn kryper på ett bord med rutig duk. På sidan av bordet finns ett glasrör. Pojken lutar sig nyfiken över kanten, medan mamman uppmuntrande följer honom med blicken. Han känner försiktigt på glaset och tittar sedan upp på sin mamma, som möter honom med ett stolt leende.

System A1, Occasion 10/9-1993

På bilderna ser vi ett barn och en kvinna. Barnet kryper på ett rutigt bord. Vi får se barnet i olika vinklar. På bild ett kryper barnet leende mot kameran. Kvinnan står bakom och tittar på barnet. På bild två kryper barnet bort från kameran. Kvinnan och barnet har ögonkontakt. På bild tre sitter barnet vid, vad som ser ut att vara en kant, men jag tror att där finns en glasskiva, på vilken barnet känner. På sista bilden ser vi återigen barnet bakifrån, men denna gången verkar det som kvinnan kallar på honom, vilket får honom att titta upp.

System A1, Occasion 4/3-1994

På papperet ser man en bildserie på ett barn och en kvinna. Barnet befinner sig på ett sorts bord, som till hälften är rutigt och till hälften är glas. Man får, från olika vinklar, se hur barnet utforskande kryper omkring under kvinnans uppmuntrande.

System A1, Occasion 3/6-1994

På papperet ser man en bildserie med ett litet barn som kryper omkring på ett rutigt bord. Man får ur olika vinklar följa barnet när det nyfiket undersöker det. Halva bordet består av en glasskiva och när barnet kommer fram till den delen känner han försiktigt och undrar om han kommer att trilla ner om han kryper över på den. Hela tiden finns en kvinna med bredvid bordet och uppmuntrar barnet.

System A2, Occasion 2/6-1993

Här är J-P. Han är en pigg liten kille. Han är med i ett projekt där man ska se hur små barn reagerar på svarta och vita rutor. J-P kryper glatt iväg och bryr sig mer om glaset som finns på sidan av bordet. Bordet är lite viktigt och inte alls lätt att gå på, men J-P bara skrattar lyckligt mot sin mamma. Mamman är flickan som står och tittar på J-P. J-P klarar testet galant, och då hans mamma lyfter upp honom från bordet är hon omåttligt stolt. J-P ler fortfarande, vilket äventyr!

System A2, Occasion 10/9-1993

Mamman sätter ner barnet, låt oss kalla honom J-P, på ett bord med rutor. Medan J-P kryper på bordet går hans mamma runt det och ställer sig på andra sidan. Då J-P följer efter märker han ett hål mellan sig och mamman, eller är det ett hål? Han känner lite på det. Det visar sig vara en glasskiva som reflekterar rutorna så att det liknar ett hål. Kommer J-P att våga krypa över "hålet" till sin mamma? Jag tycker faktiskt att det verkar så.

System A2, Occasion 4/3-1994

Barnet på bordet är nog med i någon test. Antagligen ska man kolla om barnet kryper vidare från det rutiga bordet, över glasrutan som tillsammans med en spegel ger en illusion av att vara ett hål, fram till mamman.

System A2, Occasion 3/6-1994

Jag tror att det är något slags test. Man ska se hur barnet klarar en optisk synvilla. Barnet sätts på ett rutigt bord. Halva bordet består av en glasskiva, som med hjälp av en spegel liknar ett hål. På andra sidan bordet står en kvinna, kanske hans mamma. Frågan är om barnet klurar ut att man kan krypa över glasrutan eller inte.

Appendix 2: Observed Distributions and Test Statistics

Table 1 a.

Differentiated Distribution of Graphemes and Spaces

System	Lang.	2/6-93	10/9-93	4/3-94	3/6-94
Grapheme					
A1	Sw	320	201	433	265
	Fr	239	372	293	308
A2	Sw	381	348	172	262
	Fr	261	198	160	256
Space					
A1	Sw	70	42	99	58
	Fr	58	82	64	72
A2	Sw	93	83	38	61
	Fr	51	48	37	70

Table 1 b.

GLM for Total Amount of Graphemes and Spaces

Source	Wilks	F	DF	p
Grapheme				
System	0.903	1.071	1, 10	0.325
Occasion	0.939	0.216	3, 10	0.883
Language	0.915	0.924	1, 10	0.359
Space				
System	0.961	0.408	1, 10	0.537
Occasion	0.949	0.179	3, 10	0.908
Language	0.938	0.662	1, 10	0.435

Table 2 a.

Observed Frequency Distribution of Markers of Timing

System	Lang.	Measure	2/6-93	10/9-93	4/3-94	3/6-94
A1	Sw	Period	4	3	9	5
		Fraction	0	3	5	2
		Seq. Frac	4	3	10	5
	Fr	Period	8	12	4	6
		Fraction	0	4	4	2
		Seq. Frac	8	12	4	6
A2	Sw	Period	8	7	2	6
		Fraction	3	3	2	6
		Seq. Frac	9	7	2	6
	Fr	Period	7	6	2	6
		Fraction	1	0	2	6
		Seq. Frac	5	6	2	6

Table 2 b.

GLM for Markers of Timing

Source	Wilks	F	DF	p
Period				
System	0.954	0.488	1, 10	0.501
Occasion	0.920	0.289	3, 10	0.832
Language	0.954	0.488	1, 10	0.501
Fraction				
System	0.978	0.229	1, 10	0.643
Occasion	0.594	2.282	3, 10	0.141
Language	0.914	0.941	1, 10	0.355
Seq. Fraction				
System	0.945	0.578	1, 10	0.465
Occasion	0.964	0.123	3, 10	0.944
Language	0.990	0.096	1, 10	0.762

Table 3 a.

Distribution of Blocks

System	Lang.	2/6-93	10/9-93	4/3-94	3/6-94
A1	Sw	15	9	10	5
	Fr	12	13	8	11
A2	Sw	19	19	6	13
	Fr	9	10	7	16

Table 3 b.

GLM for Blocks

Source	Wilks	F	DF	p
System	0.999	0.015	1, 10	0.903
Occasion	0.940	0.212	3, 10	0.886
Language	0.858	1.652	1, 10	0.228

Table 4 a.

Observed Distortions of Texture

System	Lang.	Measure	2/6-93	10/9-93	4/3-94	3/6-94
A1	Sw	A-dummy	8	4	12	4
		O-dummy	6	3	7	1
	Fr	A-dummy	6	6	2	5
		O-dummy	4	3	2	3
A2	Sw	A-dummy	6	13	2	5
		O-dummy	4	4	2	5
	Fr	A-dummy	2	4	3	6
		O-dummy	4	2	2	7

Table 4 b.

GLM for Textural Distortions

Source	Wilks	F	DF	p
System	0.936	0.304	2, 9	0.745
Occasion	0.696	0.594	6, 18	0.731
Language	0.830	0.921	2, 9	0.433

Table 5 a.

Viscosity and Elasticity in the Movement Patterns

System	Lang.	2/6-93	10/9-93	4/3-94	3/6-94
Viscosity					
A1	Sw	-3.5341	-2.1728	-5.0282	-2.4020
	Fr	-3.8139	-4.0270	-1.7247	-3.0244
A2	Sw	-4.7286	-4.6902	-0.7025	-3.6845
	Fr	-4.7152	-4.9618	-1.2276	-4.2954
Elasticity					
A1	Sw	-4.9204	-3.2715	-7.2254	-4.0115
	Fr	-5.8933	-6.5119	-3.1110	-4.8162
A2	Sw	-6.8080	-6.6361	-1.3956	-5.4763
	Fr	-4.7152	-4.9618	-1.9207	-6.0872

Table 5 b.

GLM for Movement Patterns

Source	Wilks	F	DF	p
Viscosity				
System	0.999	0.013	1, 10	0.912
Occasion	0.907	0.341	3, 10	0.796
Language	0.981	0.195	1, 10	0.668
Elasticity				
System	0.992	0.077	1, 10	0.787
Occasion	0.897	0.383	3, 10	0.768
Language	0.997	0.022	1, 10	0.884

Table 6 a.

Observed State Variables

System	Lang.	2/6-93	10/9-93	4/3-94	3/6-94
Figure					
A1	Sw	4	3	4	2
	Fr	3	3	3	2
A2	Sw	4	5	2	3
	Fr	0	3	3	5
Ground					
A1	Sw	3	2	2	2
	Fr	0	0	0	3
A2	Sw	0	3	2	0
	Fr	2	2	0	2

Table 6 b.

GLM for States Variables

Source	Wilks	F	DF	p
Figure				
System	0.988	0.123	1, 10	0.733
Occasion	0.982	0.061	3, 10	0.977
Language	0.905	1.053	1, 10	0.329
Ground				
System	0.986	0.146	1, 10	0.710
Occasion	0.873	0.483	3, 10	0.701
Language	0.950	0.525	1, 10	0.485

Appendix 3: Topological Configuration of A1

Figure 1. *Perspectivation of the Visual Cliff: A1 at the First Test Occasion*

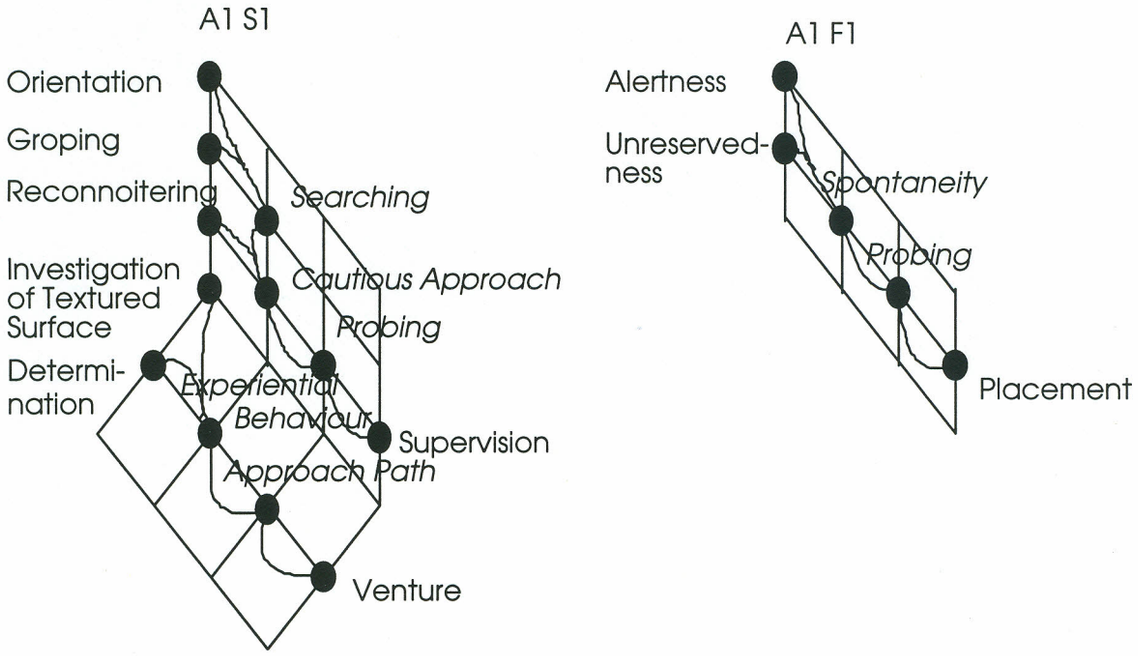
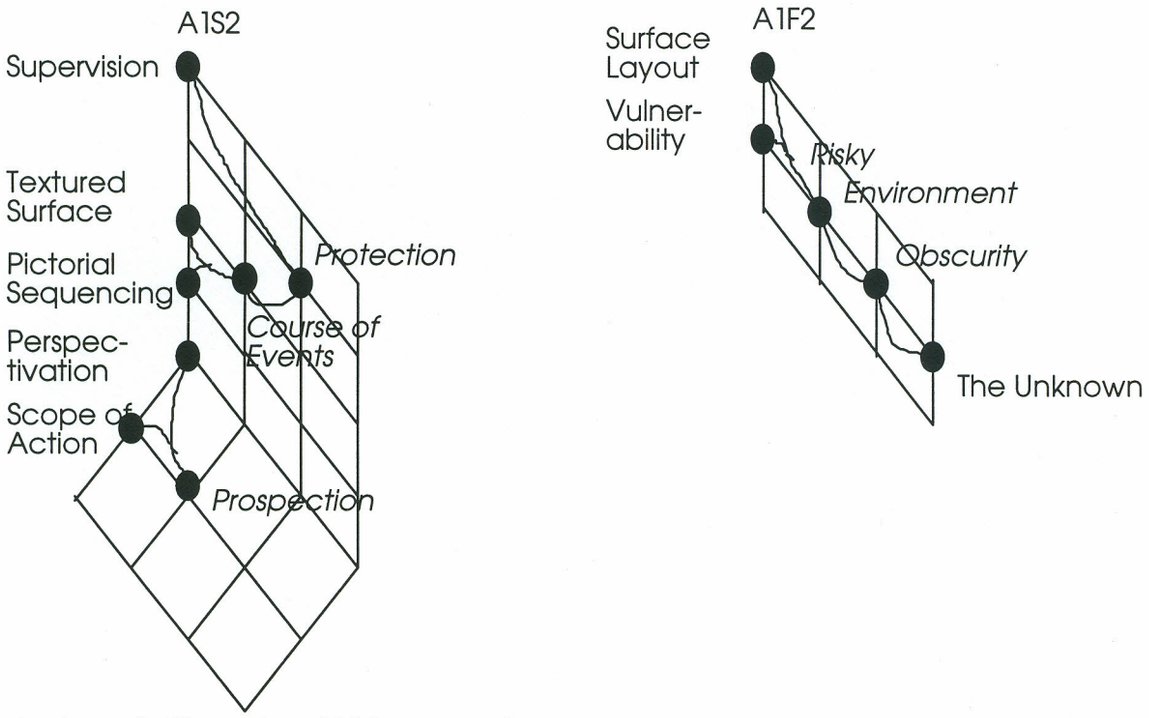


Figure 1 is the result of the text produced by A1 at the first occasion. If the continuous changes, producing the discontinuities, are small, the process develops into a homorhesic path. The path of F1 is an example and shows a configuration made up of a singularity that concerns the occurrence of movement without external influence, i. e. *"Spontaneity"*. Through the constraining attractor "Placement", the emerging final singularity addresses *"Probing"*. Thus two parameters are identified that control the developmental processes on the cliff. Any time the transition from one state into another results in an emergent novelty, a novel boundary comes into existence. In the present example *"Probing"* concerns the testing of the child's locomotion under a condition, "unknown" for the child. Consequently, global attractors emerge as invariants of pattern dynamics which means that they are exclusively a function of the temporal evolution of a perspectivated structure. In the process of producing the Swedish text (S1), a clearly different path has evolved. By naming the boundaries this path is equivalent with naming what it is that makes it distinctive. The nature of the transformations of information stored in the path that visualises changes reflecting a higher sensitivity to the experiential nature as the process progresses from one state to the next. Moreover, carefulness in locomotion and inspection of performance are characteristic of this path. The Ground component supports the careful watching of the way in which the child ventures into the "unknown". Both configurations are qualitatively changed but seem to have an underlying common sense. Probing or testing a child's co-ordination of perception and action on the basis of the established gradient is taken as an indicator of adequate behaviour in a situation where a visible surface suddenly changes into invisibility. Moreover, the absence of a Ground in F1 parses the produced texts into a kind of text that is coupled to reality or reason and text that is not.

Figure 2. *Perspectivation of the Visual Cliff: A1 at the Second Test Occasion*



As shown in Figure 2, a shift in perspective occurs at the second occasion. The French text was again produced first. The basis for the shift is the attractor state that transforms "Surface Layout" through the "Vulnerability" of the child into a *"Risky Environment"*. The following transformational step concerns the impossibility of direct information pickup or knowing what is beyond the range of the particular action taken. It follows that the process ends in the global attractor that controls *"Obscurity"* or strangeness. This perspective shift becomes even more pronounced due to the configuration of (A1 S2). The pattern dynamics achieves self-control in *"Course of Events"*, which accommodates information on a need for transcendence. Based on the terminal states "Textured Surface" and "Pictorial Sequencing" the process transforms necessarily into an ultimate behavioural solution. Because behaviour is teleonomic in nature, event perception becomes changed by selective attention, i. e. "Supervision". This means that the perspective now is focused on *"Protection"*, which of course is the key in the probing of a child's behaviour at a cliff. This global attractor addresses selective attention which implies a judgement of teleonomic fulfilment. The Ground component accentuates the theme of control. The child's intention and its consequences in the simulated environment require a perspectivation of its scope of action, i. e. *"Prospection"*. Perspective control encompasses the wholeness of properties making up a person's experiences of a physical milieu and development of a controlling singularity. In the constraints the Ground are now reduced to the minimum of two. This restriction on the partitioning of the dynamic patterns implies that only one singularity can emerge. Hence *"Prospection"* is the natural control parameter to be found in the Ground of a person acting co-operatively and constructively in the given situation.

Figure 3. *Perspectivation of the Visual Cliff: A1 at the Third Test Occasion*

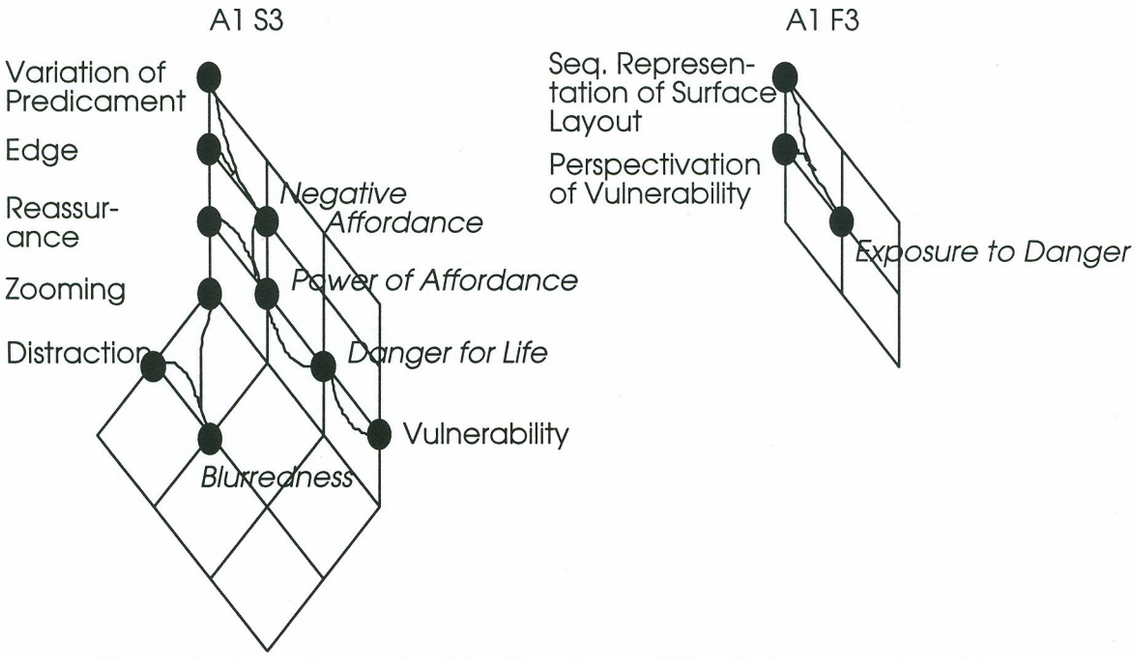
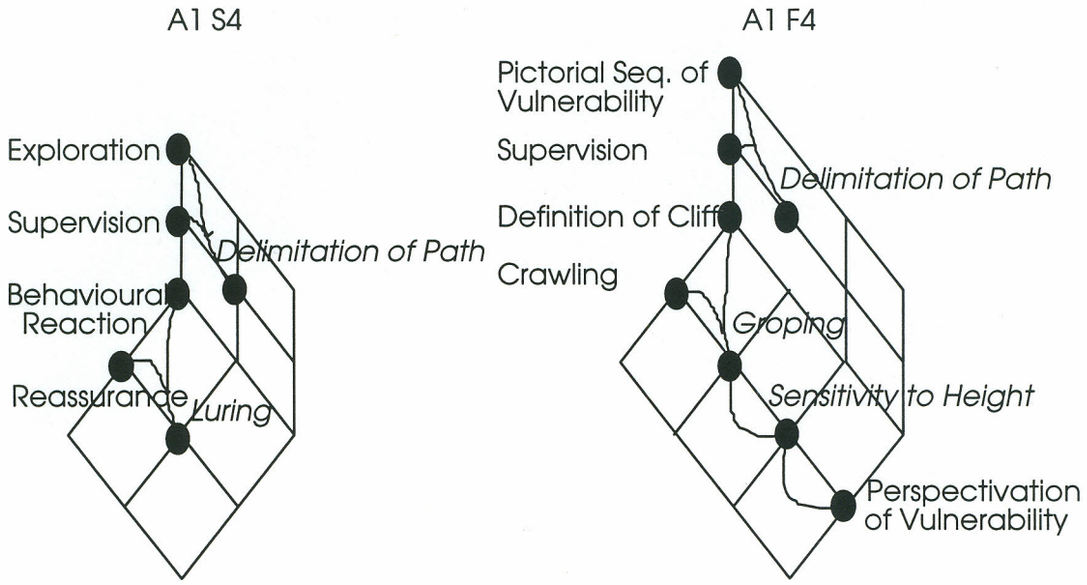


Figure 3, shows the result of the French text (F3) which was produced in succession of the Swedish (S3). The terminal state "Sequential Representation of Surface Layout" is the result of a continuous description and consequently a continuous focus on the surface laid out and its gradient. This boundary condition concerns the movement of the child. The following state, to be transited by the developing process, manifests a variation in perceptual inclination. Depending on the way in which the child locomotes over the two sides of the cliff, susceptibility to injury is anticipated. This sensitivity generates the singularity "Exposure to Danger". This control parameter suggests that the physical attraction of the cliff is in the focus of attention. The variations induced into the specific states constrained by a troublesome condition initiate the development of the path characteristic of S3. The gradient or dividing line of the surface makes a *"Negative Affordance"* emerging. It is the border line where the surface of support ends. What the child needs to perceive is not the layout but the affordance of the layout. The mother's function is here "Reassurance". It means encouraging the child in its effort to overcome the dividing line between mother and child. Because both aspects interact in a complex and dynamic way, the resulting singularity specifies the "Power of Attraction". However, the detection of the affordance of the cliff and the emotional influence by the mother are inseparable from what is feasible and favourable at the same time. The final transformational step implies an impending damage to the body which results in the global attractor *"Danger for Life"*. What is involved, is the degree to which a particular pattern of behaviour contributes to the likelihood of survival. The Ground component supports the path of the Figure component successfully. By moving toward and away from her child the mother tries to lure the child into action. But the child seems to be easily seduced by other sources of information. This circumstance makes the situation cognitively labile. The child's attention is diverted by some other external impulses. As a result, the controlling singularity emerging in the Ground is *"Blurredness"*. The presence of the mother and other external forces make the experimental task hazy and indistinct.

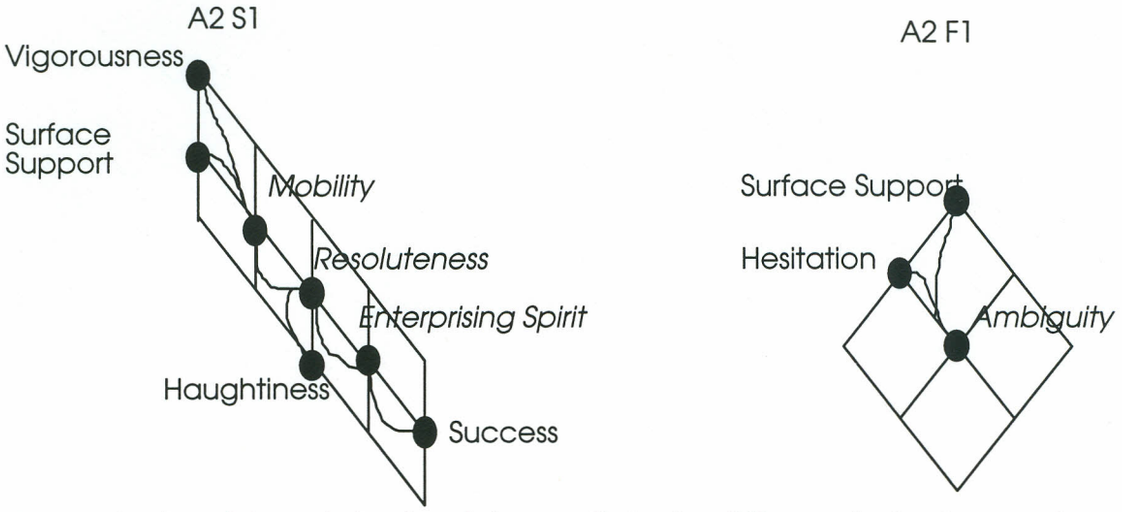
Figure 4. *Perspectivation of the Visual Cliff: A1 at the Fourth Test Occasion*



At the final test occasion, the order of writing was free of choice. Independent of which version was produced first, (A1 S4) and (A1 F4) manifest in the Figure component the same final outcome, namely *"Delimitation of Path"*. This implies a definite progression toward a point where the limits of a distinct path are in focus. According to (A1 F4), changes in the viewpoints imply awareness of different influences. Changes in the Ground are explored through "crawling", which generates the necessary transformative relations. Through a "Perspectivation of Vulnerability" the basic quality *"Sensitivity to Height"* supports the Figure, because it is taken as an expression of a more or less pronounced formation of an avoidance strategy. No doubt, the central control parameter matters an actively operating child's judgement.The perspectivation expressed in (A1 S4), begins with "Exploration" which is an exposition of evoked variations in behaviour at a higher level of integration. Efficient transaction with the environment rests on "Supervision". Moreover, a slight digression appears in the Ground. The child's mother is conceptualised as an agent whose task is to induce locomotion. Thus the delimitation of the infant's path is only partly dependent on the functioning of his actions at the brink. The terminal state "Reassurance" transforms the supervising mother into the experimental function of a lure. Thus the physical attraction of the defined "Cliff " competes with the *"Luring"* of the mother.

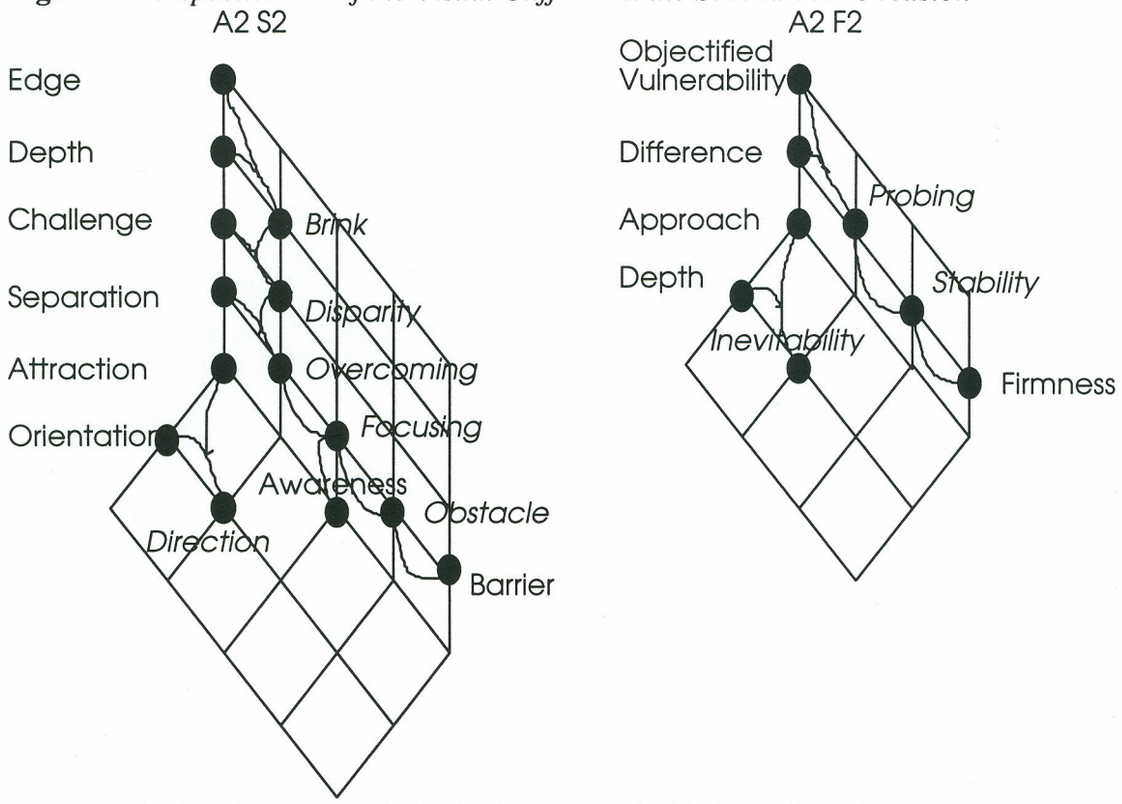
Appendix 4: Topological Configuration of A2

Figure 1. *Perspectivation of the Visual Cliff: A2 at the First Test Occasion*



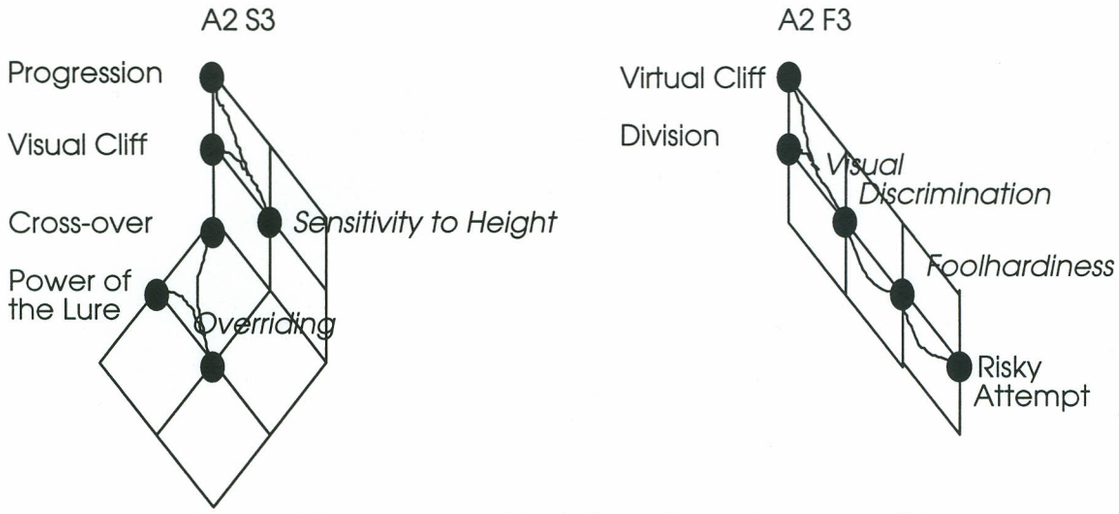
An examination of the path developed shows a distinctive difference in the absence of a Figure component in (A2 F1) but the presence of a Ground component. The focus is on "Surface Support". This terminal state is a natural beginning. It is of fundamental import for the movement of the child that he always can feel and see the surface that supports his locomotion. The following terminal state constrains mobility somewhat. Because of conflicting information the child delays his actions, which gives expression to "Hesitation". According to the definition of the cliff, optical information becomes contradictory to haptic information. This inbuilt factor transforms the process into *"Ambiguity"*. Any test situation builds on ambiguity in regard to the behavioural outcome. The Figure component of (A2 S1) initially gives expression to "Vigorousness" which means a favourable regard of the child's physical and mental strength. The "Surface of Support" is the transformational constraint that allows the process to enter the state of *"Mobility"*. Depending on the way in which the child locomotes over both sides of the surface, his degree of responsiveness to the cliff is concluded. In the following transformational step, "Haughtiness" or disregarding the cliff's dangerousness results in *"Resoluteness"*. Advancing over the cliff in order to gain "Success" develops into the global attractor *"Enterprising Spirit"*. This means a certain boldness in character.

Figure 2. *Perspectivation of the Visual Cliff: A2 at the Second Test Occasion*



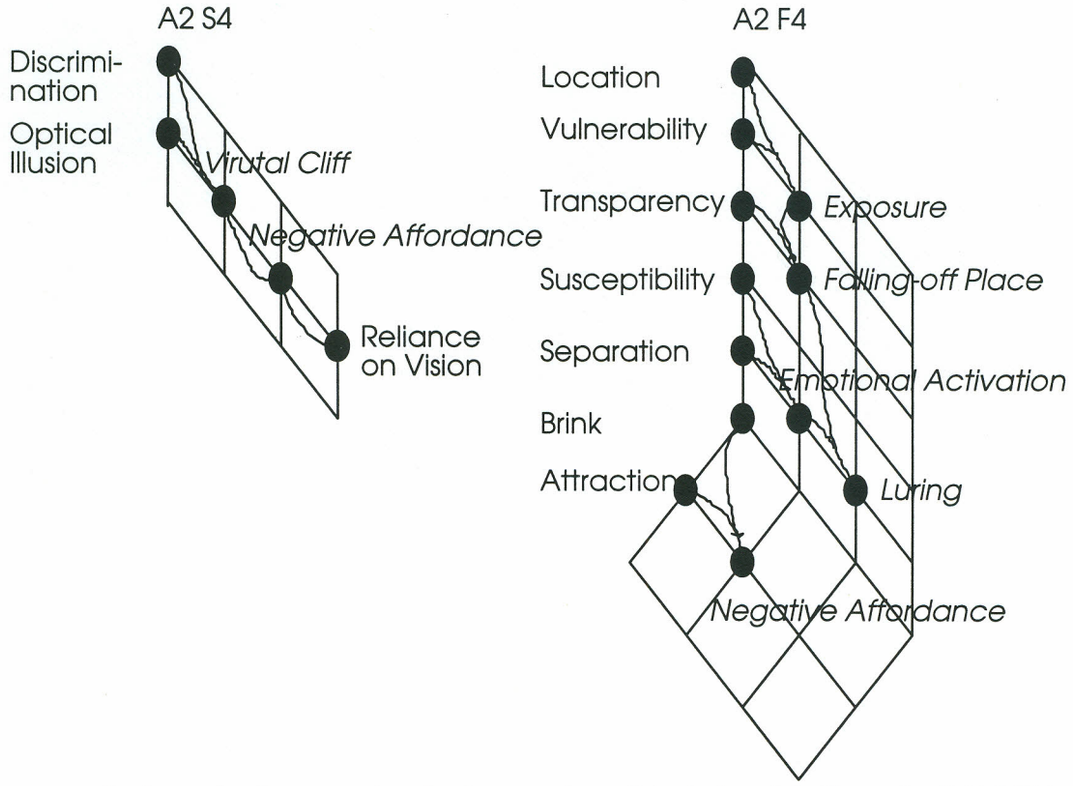
A fearless locomotory infant is the prototypical information of (A2 F2) and captured by the initial terminal state "Objectified Vulnerability". The basic meaning is derived from vulnerability which is demonstrable and thus real and external to the mind. As such it is the beginning of a path toward its verifiability. The next following state governs the course of the path toward selectivity to but one of several sources of information available, i. e. *"Probing"*. This singularity leads to a determination of a behavioural pattern. The final constraint transforms the *"Probing"* into the global attractor *"Stability"*, which characterises the child's behavioural pattern as reproductive and reliable. The path in the Ground of (A2 F2) is complementary to the Figure. The force in causing the "Approach" to "Depth" is external to the child and implies that his course of action may be terminated by a one-time event. The terminal state "Edge" as the dividing line of transition initiates the development of a path in (A2 S2). The extent of downward slanting transforms the "Edge" into a "Brink", that is, the upper edge of a sheer. However, its steepness or "Depth" has to be put in relation to the measure of the child's body. By calling the child, "Challenge" is taken in full use. His resources in picking up the degree of differences between the two sides of the surface are examined. To be able to differentiate or discriminate the information that specifies the degree of falling-off, an attempt to master the "Separation" leads to *"Overcoming"*. Moreover "Awareness" directs the child's effort of concentrating on his relation to the ground terminates in *"Focusing"*. To perceive a cliff is to become conscious of its negative affordance. In general, an affordance implies *"Focusing"* on the surface layout relative to and co-ordinated with one's body. The path in the Ground supports *"Focusing"* on the surface layout. The initial state emphasises the "Attraction" that some natural occurring events exert. By changing one's position relative to the point of attraction, a *"Direction"* is established. The final transformative step involves a "Barrier" which is a general case of the terrain features that usually prevent locomotion in the pretended *"Direction"*. The resulting "Obstacle" on the other hand implies a transparent objective, that stands in proportion to an individual's possible management.

Figure 3. *Perspectivation of the Visual Cliff: A2 at the Third Test Occasion*



The "Virtual Cliff" (A2 F3) provides information under two conditions. The "Division" of a large sheet of glass into two parts has been done with the purpose of testing the import of *"Visual Discrimination"* in locomoting over the glass floor. To undertake a "Risky Attempt" of crossing the deep side unfolds *"Foolhardiness"* as global attractor, characteristic of a venturesome or reckless child. "Progression" toward the "Visual Cliff" in (A2 S3) determines whether or not the child will go forward and over the cliff. The visual discrimination of depth at the end of a surface supporting advancement is taken as a clue to a child's *"Sensitivity to Height"*. This singularity is the fundamental control factor whose behavioural quality is expressed through showing fear. The path in the Ground makes obvious that the controlling factor *"Sensitivity to Height"* is not conceived of as a natural clue to danger. "Cross-over" is taken as the successful behavioural outcome. And this is made dependent on the "Power of the Lure". The assumption of an "innate" capacity of recognising falling-off places seems to be absent at least with respect to A2. The controlling singularity is *"Overridding"* which implies non-consciousness in regard to the ecological significance of a cliff.

Figure 4. *Perspectivation of the Visual Cliff: A2 at the Fourth Test Occasion*



In the task of contrasting the locomotion of the infant, his "Location" (A2 F4) has consequences for direct information pickup. Since it is fundamental for the survival of the body, the child has to act according to changes in the environment. As a result, *"Exposure"* to a changing surface implies that the child has to extract the invariants in the optical information flow field. The next state is "Transparency" which provides a constraint that governs the perceptual process towards that part of the glass top where optical information is absent. Consequently, the relationship between surface and the supported child changes into a *"Falling-off Place"*. At this point in the development of a path, an unexpected jump generates a hysteresis in the path. A new beginning is made. The state "Susceptibility" signals a deep affection, probably because of strong feelings for the mother. This state becomes transformed through "Separation". The resulting *"Emotional Activation"* gives evidence to an "ego-motion" encompassed in the perceptual outcome of A2. This conjecture becomes substantial at the point where the second path meets the first. The result is the global attractor *"Luring"*. The infant's behaviour is no longer dependent on his sensitivity, instead the bonding to the mother controls the behaviour. The path in the Ground is supportive. A2 has been sensitive to the method of inducing locomotor crossing. But *"Negative Affordance"* lacks ecological significance. The mother is the object of interest both from a cognitve and emotional point of view. "Discrimination" (A2 S4) concerns the information picked up at the intersection of the two sides. Moreover, "Optical Illusion" governs the process close to the question of "mistaken perception" and the *"Virtual Cliff"* emerges as terminus. "Reliance on Vision" means that the process ends in *"Negative Affordance"*. If it is perceived correctly, the surface of support looks like what it is but has no significance.

Appendix 5:

Grouping of Textual Strings

French: *Figure-Component*

System A1 Occasion 2/6-1993	*Literal English*
CLUSTER: 1 Alertness	
1 un bébé et sa maman	a baby and his mama
5 son bébé	her baby
6 Y	Y
7 très curieux	very curious
CLUSTER: 2 Unreservedness	
8 Il(lui) tout	He everything
9 tout	everything
CLUSTER: 3 Placement	
2 le bébé	the baby
3 Dans les photos differentes	at the various pictures
nous X verre	we X glass
4 verre	glass

System A1 Occasion 10/9-1993	
CLUSTER: 1 Layout	
1 quatre petite pictures	four little pictures
2 un enfant et une femme	an infant and a woman
4 derrière	behind
6 hors	outside
7 un plaque	a table top
CLUSTER: 2 Vulnerability	
3 l'enfant	the infant
CLUSTER: 3 The Unknown	
5 Y	Y

French: *Ground-Component*

System A1 Occasion 3/6-1994	
CLUSTER: 1 Definition of Cliff	
1 de pictures d' un enfant	at pictures of an infant
6 de deux parts - un à carreaux	in two parts - a checked
et un transparent, comme une fenêtre	and a transparent part, like a window
CLUSTER: 2 Crawling	
2 sur un table à carreaux	on a checked table
5 à ses mains et ses genoux	with his hands and knees
CLUSTER: 3 Perspectivation of Vulnerability	
3 dans quatre pictures où nous l'enfant	on four pictures there you the infant
4 sur des angles differents	over different apexes

Swedish: *Figure-Component*

System A1 Occasion 2/6-1993

CLUSTER: 1	Orientation	
1 man en bildserie		you a series of pictures
4 det Y		that Y
CLUSTER: 2	Groping	
5 fram		forward
6 han försiktigt		he cautious
CLUSTER: 3	Reconnoitering	
7 han ner om över på den Y		he down if over to the Y
8 ner		down
CLUSTER: 4	Supervision	
2 Man barnet		You the child
3 barnet		the child
9 Hela tiden en kvinna		All the time a woman

System A1 Occasion 10/9-1993

CLUSTER: 1	Supervision	
2 sig		himself
6 Y		Y
5 barnet omkring under kvinnans		the child on every side under the woman's
CLUSTER: 2	Textured Surface	
3 rutigt		checked
4 glas		glass
CLUSTER: 3	Pictorial Sequencing	
1 man en bildserie		You a series of pictures

System A1 Occasion 4/3-1994

CLUSTER: 1	Variation in Predicament	
1 vi ett barn och en kvinna		we a child and a woman
2 Vi barnet i olika vinklar		We a child from various angles
4 barnet bort		the child away
5 ögonkontakt		eye contact
8 att_där X en glasskiva på barnet Y		that there X a sheet of glass at the child Y
9 en glasskiva		a sheet of glass
10 Y		Y
11 vi återigen barnet bakifrån		we again the child from behind
12 det kvinnan på honom		that the woman at him
CLUSTER: 2	Edge	
6 ut		out
7 en kant		an edge
CLUSTER: 3	Reassurance	
13 honom		him
14 upp		up
CLUSTER: 4	Vulnerability	
3 barnet		the child

System A1 Occasion 3/6-1994

CLUSTER: 1	Exploration	
1 vi en bildserie		we a series of pictures
2 ett glasrör		a glass tube
3 sig nyfiken		himself curious
6 försiktigt		carefully
CLUSTER: 2	Supervision	
4 medan mamman honom med blicken		meanwhile the mother him with her eyes
5 honom		him

Swedish: *Ground-Component*

System A1 Occasion 2/6-1993

CLUSTER: 1	Investigation of Textured Surface	
1 omkring på ett rutigt bord		on every side on a checked table top
2 ur olika vinklar		from various apexes
3 av en glasskiva		of a sheet of glass
CLUSTER: 2	Determination	
4 till den delen		to that part
5 om han ner över på den Y		if he down over on the Y
CLUSTER: 3	Venture	
6 om han över på den Y		if he over on the Y
7 över på den Y		over on the Y

System A1 Occasion 10/9-1993

CLUSTER: 1	Perspectivation	
1 på ett barn och en kvinna		at a child and a woman
3 från olika vinklar		from various apexes
CLUSTER: 2	Scope of Action	
2 på ett sorts bord		on some sort of table
4 omkring under kvinnans		on every side under the woman's

System A1 Occasion 4/3-1994

CLUSTER: 1	Zooming	
1 på ett rutigt bord		on a checked table
2 i olika vinklar		in different apexes
3 mot kameran		toward the camera
6 från kameran		from the camera
7 vid Y		at Y
8 på barnet Y		at the child Y
CLUSTER: 2	Distraction	
4 bakom Kvinnan på barnet		behind the Woman on the child
5 på barnet		at the child
9 på honom		at him

System A1 Occasion 3/6-1994

CLUSTER: 1	Behavioural Reaction	
1 på en baby och hans mamma		at a baby and his mama
2 på ett bord		on a table
3 över kanten		over the edge
CLUSTER: 2	Reassurance	
4 på glaset		at the glass
5 sedan upp på sin mamma		thereafter up at his mama

French: *Figure-Component*

System A2 Occasion 10/9-1993

CLUSTER: 1	Objectified Vulnerability	
1 un enfant		an infant
2 Jean-Pierre		Jean-Pierre
7 se		himself
CLUSTER: 2	Difference	
3 un fenêtre		a window
4 les carreaux		checker squares
CLUSTER: 3	Firmness	
5 On Jean-Pierre se		You Jean-Pierre himself
6 Jean-Pierre se		Jean-Pierre himself

System A2 Occasion 4/3-1994

CLUSTER: 1	Virtual Cliff	
4 l'illusion		an illusion
5 un trou, jusqu'		a hole, to the end
CLUSTER: 2	Division	
1 part		part
CLUSTER: 3	Risky Attempt	
2 peut-être		perhaps
3 l'enfant de la table a carreaux de la fenêtre		the child from the checked table to the window

System A2 Occasion 3/6-1994

CLUSTER: 1	Location	
1 c'(ce) un enfant		that a child
6 là		there
7 une table		a table
CLUSTER: 2	Vulnerability	
2 un enfant		a child
3 part		part
CLUSTER: 3	Transparency	
8 y(là)		there
9 une vitre et un miroir		a window and a mirror

CLUSTER: 4 Susceptibility	
4 On l'enfant de la femme,	You a infant from the woman
peut-être sa maman à l'autre côté	perhaps his mama to the other side
11 On Y	You Y
12 Y	Y
CLUSTER: 5 Separation	
5 l'enfant de la femme,	the child from the woman
peut-être sa maman à l'autre côté	perhaps his mama to the other side
10 L'enfant de la femme	the child from the woman

French: *Ground-Component*

System A2 Occasion 2/6-1993

CLUSTER: 1 Surface Support	
1 dans un projet	in a project
2 sur les carreaux noires et blancs	on black and white checkered squares
5 à sa maman	to his mama
CLUSTER: 2 Hestitation	
3 de Il(lui) ne sur la table	of he not on the table
4 sur la table	on the table

System A2 Occasion 10/9-1993

CLUSTER: 1 Approach	
1 sur la table à carreaux	on the checked table
2 de sa mère sur la fenêtre	from his mother over the window
CLUSTER: 2 Depth	
3 à un trou	of a hole

System A2 Occasion 3/6-1994

CLUSTER: 1 Brink	
1 d' une expérimentation	of an experiment
3 à carreaux	of checked
4 à une trou	of a hole
CLUSTER: 2 Attraction	
2 de la femme, peut-être	from the woman, perhaps
sa maman à l'autre côté	his mama, to the other side
5 de la femme	from the woman

Swedish: *Figure-Component*

System A2 Occasion 2/6-1993

CLUSTER: 1 Vigorousness	
1 J-P	J-P
2 en pigg liten kille	a brisk little boy
7 lite vickigt och inte alls lätt	somewhat wobbly and not at all easy
8 lyckligt	luckily
9 flickan	the girl
10 flickan på J-P	the girl at J-P

CLUSTER: 2 Surface Support	
3 man små barn på svarta	you young infants on black
och vita rutor	and white squares
4 små barn på svarta och vita rutor	young infants on black and white squares
CLUSTER: 3 Haughtiness	
12 upp honom	up him
13 hon omåttligt stolt	she boundless proud
CLUSTER: 4 Success	
5 glatt iväg	animated away
6 sig mer	himself more
11 testet galant	the test gallant
14 fortfarande, vilket äventyr	ongoing, what an adventure

System A2 Occasion 10/9-1993

CLUSTER: 1 Edge	
8 lite	little
10 rutorna	the checked squares
11 ett hål	a hole
14 faktiskt	in fact
15 så	so
CLUSTER: 2 Depth	
6 han ett hål	he a hole
7 det ett hål	that a hole
CLUSTER: 3 Challenge	
12 J-P	J-P
13 X över hålet till sin mamma	X over the hole to his mama
CLUSTER: 4 Separation	
4 hans mamma runt det	his mama around that
Medan J-P sig på andra sidan	Meanwhile J-P himself on the other side
5 sig	himself
9 en glasskiva	a sheet of glass
CLUSTER: 5 Awareness	
1 ner barnet	down the child
2 oss	us
3 honom J-P	him J-P

System A2 Occasion 4/3-1994

CLUSTER: 1 Progression	
1 nog	sufficient
2 man	you
3 vidare	further
CLUSTER: 2 Visual Cliff	
4 en illusion	an illusion
5 ett hål, fram	a hole, foreward

System A2 Occasion 3/6-1994

CLUSTER: 1 Discrimination	
1 Jag något slags test	I some kind of test
2 något slags test	some kind of test
6 Barnet	The child
7 ett hål	a hole
8 en kvinna, kanske hans mamma	a woman, perhaps his mama
CLUSTER: 2 Optical Illusion	
5 en optisk synvilla	an optical illusion
9 ut	out
CLUSTER: 3 Reliance on Vision	
3 Man barnet en optisk synvilla	You the child an optical illusion
4 barnet en optisk synvilla	the child an optical illusion
10 man över glasrutan eller inte	you over the glass square or not

Swedish: *Ground-Component*

System A2 Occasion 10/9-1993

CLUSTER: 1 Attraction	
1 på ett bord	on a table
6 på det Y	on that Y
7 över hålet till sin mamma	over the hole to his mama
CLUSTER: 2 Orientation	
2 på bordet	on the table
3 på andra sidan	on the other side
CLUSTER: 3 Barrier	
4 efter J-P han ett hål mellan sig och mamman	after J-P he a hole between himself and mama
5 mellan sig och mamman	between himself and mama

System A2 Occasion 4/3-1994

CLUSTER: 1 Cross-over	
1 om barnet vidare från det rutiga bordet över glasrutan	if the child further from the checked table over the glass square
2 från det rutiga bordet över glasrutan	from the checked table över the glass square
CLUSTER: 2 Power of Lure	
3 av tillsammans med en spegel ett hål, fram till mamman	of together with a mirror a hole, forward to mama
4 till mamman	to mama